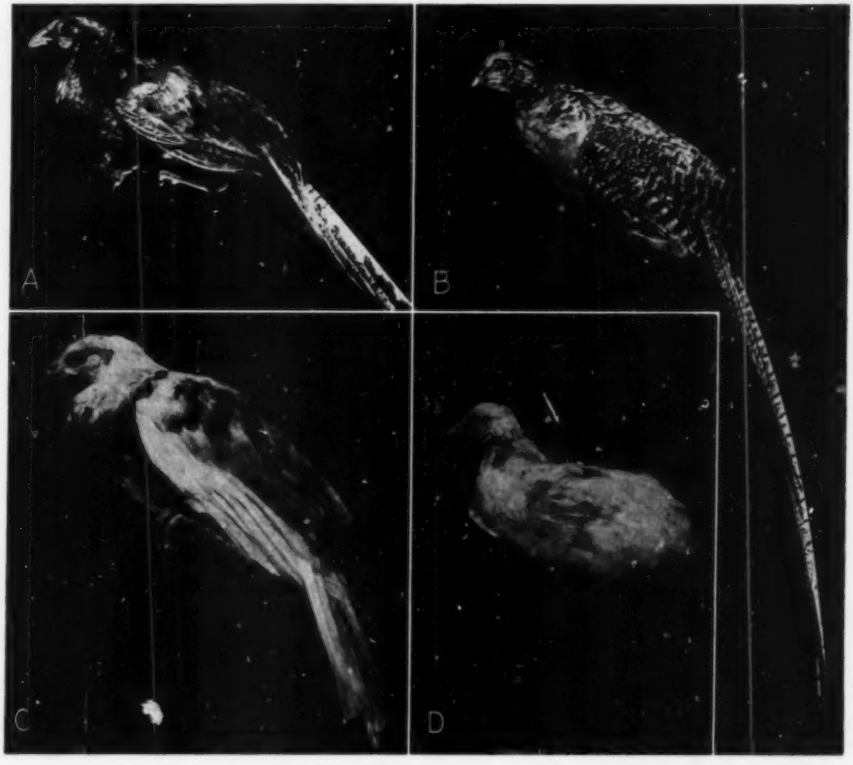
The Journal of HEREDITY



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Chemically Induced Tetraploidy in Mammals
Evolution of Hawkweeds through Polyploidy
Top-flight Princeton Alumnae Have More Children

VOLUME 30 DECEMBER, 1939 NUMBER 12

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In cooperation with the American Eugenics Society

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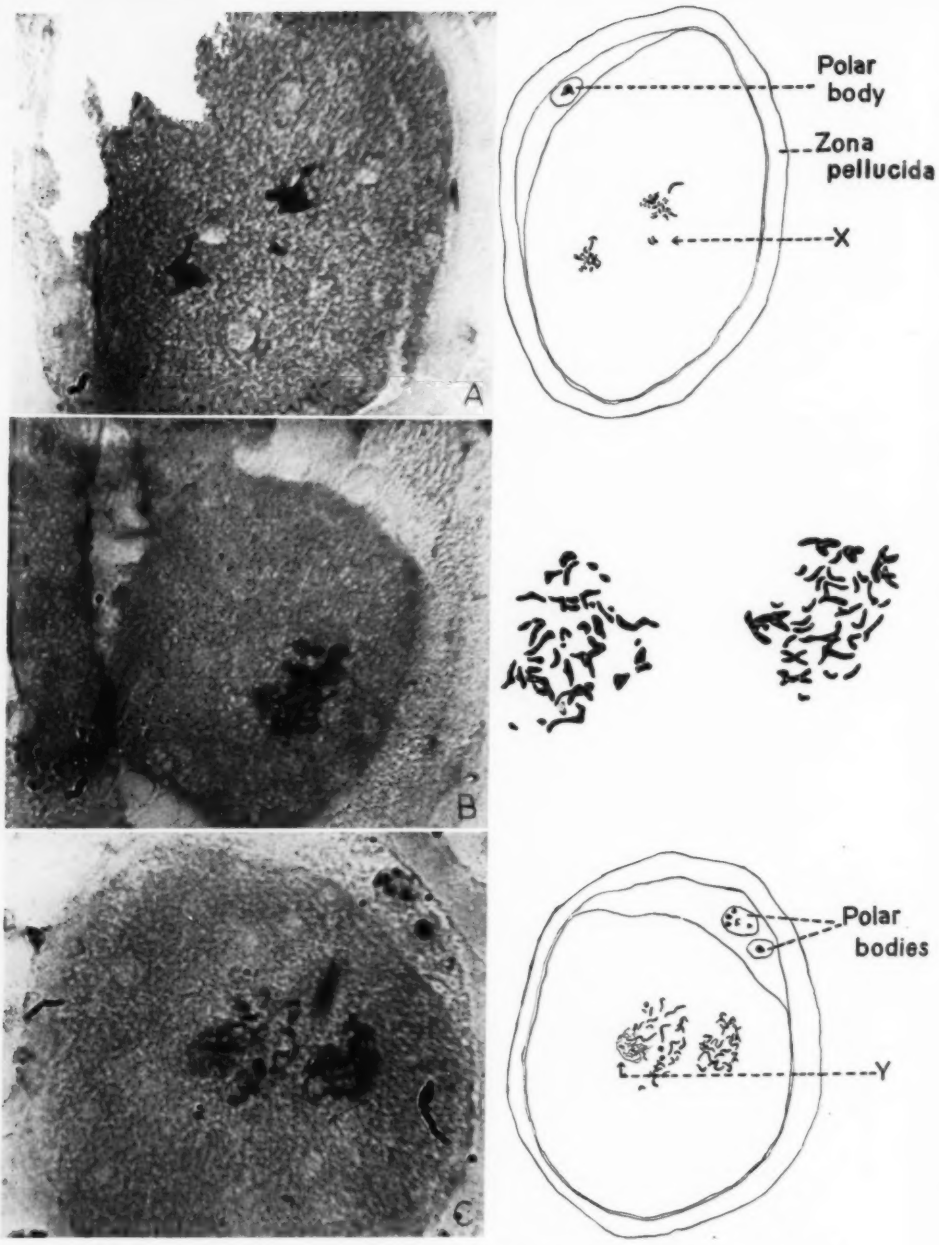

COLCHICINE TREATED RABBIT OVA SHOWING CHROMOSOME DOUBLING

Frontispiece

Microphotographs and camera lucida drawings of sections of three fertilized ova treated with colchicine. In each of them the male and female pronuclei are present, and various stages of development are shown. *A* shows the two pronuclei as dark areas. The camera lucida drawing shows the details of the chromosomes. They are typical of those found in somatic cells, except that some of them have begun to split. At *X* a chromosome which has wandered away from the main set has clearly undergone fission. *B* shows that both sets of the pronuclei chromosomes have undergone division to form two diploid sets in the one-celled ovum. Only one pronucleus is in focus in the photograph. *C* shows a somewhat later stage in the process. Here the pronuclei chromosomes have divided and a nucleus has begun to reform, as shown at *Y*.

THE EFFECTS OF MITOSIS-INHIBITING TREATMENTS ON NORMALLY FERTILIZED PRE-CLEAVAGE RABBIT EGGS*

The Comparative Behavior of Mammalian Eggs *in vivo* and *in vitro*—V.

GREGORY PINCUS and C. H. WADDINGTON

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POLYPLOIDY in mammals has never to our knowledge been reported, although Painter[2] has observed certain giant amnion cells with very large chromosome numbers. Pincus[3] has observed a tetraploid chromosome complement in certain artificially activated rabbit ova, but those definitely identifiable as tetraploid were not cleaved ova. Our objective in undertaking these experiments was to see if certain treatments applied to the normally fertilized rabbit egg just before the first mitotic division would sufficiently inhibit cell division without markedly affecting chromosome division so as to establish polyploid rabbit eggs. We have definite evidence that a tetraploid chromosome complement may be established in a single-celled rabbit ovum, but no unequivocal evidence demonstrating that such eggs will cleave normaily. In fact, our data indicate that the cleavage of tetraploid ova must, if anything, be considerably slower than that of normal diploid eggs.

Methods

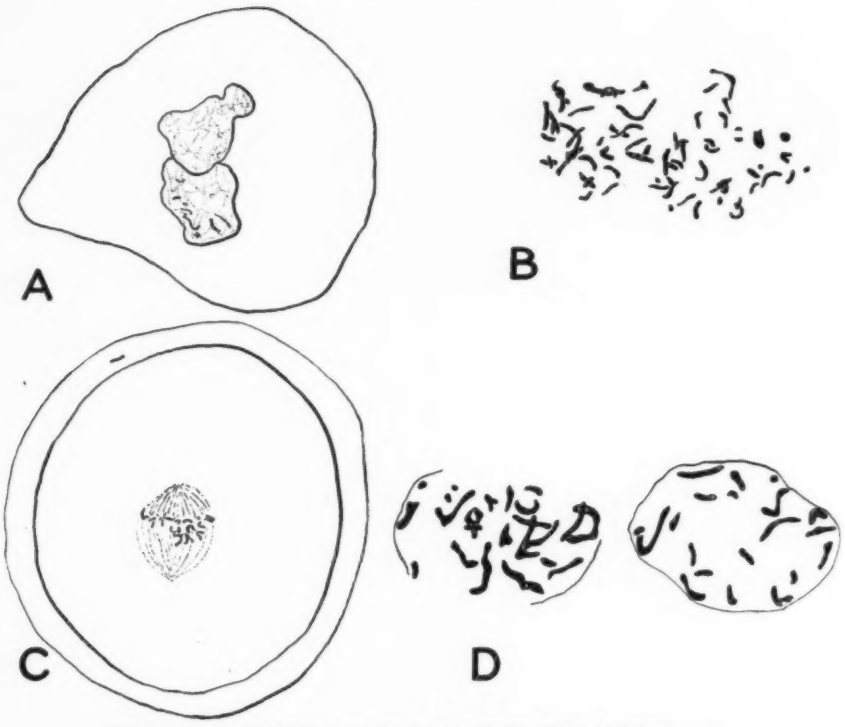
Rabbits superovulated by methods previously described[3] were sacrificed at the 19th to 21st hours after copulation and the ova flushed from the tubes with Pannet-Compton solution. All the treatments of 40 minutes or less were carried on in Pannet-Compton solution. The longer treatments were carried on in the serum medium used for subculture. Ova were cultured for 22 to 24 hours in 10 cc. Carrel flasks containing six to eight cc. of rabbit serum, removed from culture, fixed in Bouin's solution, sectioned and stained. Eggs were treated with dilute solutions of ether, ethyl alcohol and colchicine, or exposed briefily to supranormal temperatures (see Table I).

Results

The effectiveness of the various types of treatment can be judged by two criteria: (1) by determining if the cleavage rate has been significantly inhibited when comparison is made with a suitable control series; (2) by cytological examination of the ova to determine alterations in chromosome or nuclear behavior.

The data pertinent to the first criterion are presented in Table I. It will be noted in that in our control series of 27 ova 92 per cent had segmented to four to eight cells (column seven) after a day's culture and none had fragmented into non-nucleated blastomere-like cells (column eight). With this number of ova the standard error for per cent cleaved to four to eight cells is $\pm$ 5.2 per cent. In column seven we italicized all those cleavage percentages which are significantly less than the control percentage. It will be noted that all treatments except one per cent ether for three hours, exposure to 45 degrees C. for five minutes, and exposure to 0.0005 per cent colchicine for 30 minutes led to a significant inhibition of the cleavage rate. The latter nonetheless did lead to fragmentation of 14 per cent of the ova (column eight), and the one per cent ether treatment is open to suspicion because the ether evaporated very rapidly when added to the Pannet-Compton solution. It is obvious that in all but the shortest

*This research was aided by grants from the Josiah Macy, Jr., Foundation and the Milton Fund of Harvard University.



NORMAL AND CHROMOSOME-DOUBLED FERTILIZED OVA

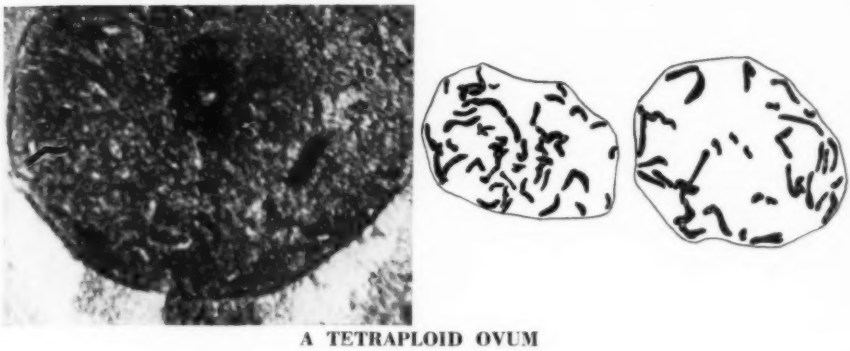
Figure 1

A, camera lucida drawing of a section of an ovum of the colchicine series. In this egg the pronuclei have reformed after treatment but each is now diploid, not haploid as it was originally. *B* is a camera lucida drawing of the chromosomes in one section of a one-celled ovum of the colchicine series. This is after fusion of the pronuclei. There are 71 chromosomes in this section, where 44 chromosomes is the normal diploid number in the rabbit. *C*, camera lucida drawing of a section of an untreated fertilized ovum at metaphase showing some of the chromosomes assembled on the spindle. *D* shows a camera lucida drawing of a diploid set of prophase chromosomes of one of two cells formed from a cleaved ovum of the colchicine series. Here colchicine treatment has not been effective in doubling of chromosome number.

exposure to 47.5 degrees C. the ova were completely prevented from further development and even in the three minute exposure only three of the eleven ova cleaved to two to three cells, but no further. It is obvious that the ova are very sensitive to slight changes in temperature above 45 degrees C.

Among the treated ova we have been able to make chromosome counts in 40 of a total of 200 ova. These data are presented in Table II.

It is not difficult to distinguish polyploid chromosome numbers in the rabbit since the diploid number is 44 and triploids will have 66, tetraploids 88 chromosomes. In many cases where the number has been clearly more than 66 we have called the ova tetraploid without making the attempt to get an exact count. A tetraploid complement ordinarily has so many chromosomes overlying each other that clear distinction of each individually is extremely difficult. Of the 40 eggs with good mitotic figures, 15 were definitely tetraploid in the sense that one cell contained $4n$ chromosomes. Most of these (13) were in the colchi-



A TETRAPLOID OVUM

Figure 2

Photomicrographs of part of a prophase nucleus in one of two cells in an ovum which has undergone the first cleavage. A study of this section and some adjacent sections (drawing at extreme right) shows clearly that this cell is tetraploid. The double number of chromosomes has been established to one cell division in the early formation of the embryo.

cine series, only two being in all the other series combined (Table II). In all of the colchicine treated series except for the 0.0041 per cent concentration diploid as well as tetraploid chromosome sets were observed, but in the colchicine series the proportion of tetraploid complements is higher than the diploid.

The data on the frequency of tetraploid ova in the colchicine series may be deceptive because of the rather special effect of colchicine upon the ova. It will be noted (Table I) that the proportion of colchicine-treated eggs which cleave to four to eight cells is very low. This is especially true of the ova cultured continuously in the highest concentration. The low (or zero) cleavage percentages appear to be due to the fact that colchicine inhibits almost all cytoplasmic movements and slows down nuclear activities as well. Thus the reason why all the tetraploids of the colchicine series are found in one-cell stage is because cleavage has been inhibited, and the two pronuclei have formed typical somatic chromosomes which split, probably *in situ* since no spindle forms. In some ova these unoriented chromosomes may proceed to reform diploid nuclei, in other ova they wander in small groups into the cytoplasm and may form small subnuclei. Due to the slowing down of these mitotic processes we have thus been able to find more ova with clear chromosome figures in the egg-cells in the colchicine series than in the other series. In some of the ether-treated ova especially some of the blastomeres contain very large nuclei which are probably tetraploid. We have made no attempt to compare nucleus sizes in the various groups since the nucleus in normally cleaving rabbit ova varies markedly in size from telophase to prophase, and the best we could obtain would be a rather dubious set of statistical comparisons. Further, there appears to be fairly good synchronization in cleavage order in certain sets of ova (note only two spindles seen in the 32 eggs of the one per cent ether series), and very poor synchronization in others. This would serve to give quite false comparisons of nuclear size from set to set.

In the Frontispiece and Figures 1 and 2 we present ova showing certain of the typical effects of treatments employed.

At the time these ova were removed most of them contained two pronuclei approaching each other or fusing centrally.[1, 3] In normally developing ova the nuclear membranes break down and the chromosomes become aligned on the cleavage spindle (Figure 1*C*) rather rapidly. The first effect of the mitosis-inhibiting treatment is to arrest the inward

movements of the pronuclei so that if they are somewhat separated the chromosomes form at separate loci as in Frontispiece *A*. A second effect of these treatments is the prevention of spindle formation. Depending apparently on the degree of inhibition of cytoplasmic movement the chromosomes may migrate somewhat (as in Frontispiece *A* at *X*) or remain *in situ* and split. The figure shows an ovum section in which chromosome division in well separated pronuclei has just begun; Frontispiece *B* contains drawings of two complete diploid sets located in different portions of the same one-celled ovum. Nuclei slowly reform after the chromosome division. The beginnings of such reformation is shown in Frontispiece *C* which contains parts of the two pronucleus chromosome sets. Two new pronuclei may form again and approach each other (as in Figure 1*A*), but it is also probable that a single tetraploid nucleus may form from the complex shown in Figure 1*B*, wherein the two original sets are indistinguishable.

As recovery from the inhibiting treatment occurs the chromosomes of the diploid pronuclei presumably line upon a single new spindle and division as a tetraploid occurs. We have seen no ova indicating multiple spindles are formed. In Figure 2 we present drawings of a somatic prophase in a two-celled tetraploid ovum; the chromosomes of an exactly similar stage in a diploid ovum are given for comparison in Figure 1*D*.

TABLE I. The effect of various treatments during the cleavage rate of rabbit ova.

Treatment	No. of eggs	1 cell	2-cell	3-4 cells	Fragments	5 in 4 to 8 cells	Segmented
Control	57	--	--	10	--	47	0
2% ether for 8 minutes	7	--	6	1	1	14	14
1% ether for 2 hours	17	--	--	17	--	100	0
1-1/2% ether for 2-1/4 hrs.	7	--	6	1	--	14	0
1+1/2% alcohol for 40 mins.	16	--	2	10	2	63	14
6°C for 6 hours	9	--	5	3	4	22	44
18 C for 8 mins.	17	--	4	8	--	71	0
47.5° for 2 mins.	11	8	3	--	--	8	0
47.5° for 2-1/2 mins.	10	10	--	--	--	0	0
47.5° for 10 mins.	8	8	--	--	--	8	0
0.00008% colchicine contin.	15	8	8	--	10	8	67
0.00004% colchicine contin.*	16	7	7	2	4	12	29
0.00041% colchicine contin.	21	7	1	1	10	8	67
0.00041% colchicine for 2 hrs. 30 mins.	12	4	2	2	4	17	33
0.0008% colchicine 30 mins.	14	-	2	9	2	64	14
0.00016% colchicine continuous	8	8	8	-	-	0	0
0.00041% colchicine continuous	10	10	8	-	9	8	80

*Other exhibited very rapidly.

TABLE II. Summary of chromosome number determinations in treated ova.

	Total Number of eggs	No. of eggs with diploid-triploid complement	No. of eggs with tetraploid complement	Cell stage of tetraploid
1% ether for 2 hrs.	20	2	---	---
1-1/2% ether for 2-1/4 hrs.	7	2	1	2
2% ether for 8 mins.	7	2	---	---
1-1/2% for 40 mins.	16	2	---	---
6°C for 6 hrs.	9	1	---	---
40°C for 2 mins.	10	1	1*	2
47.5°for 2 mins.	11	2	---	---
47.5 for 2-1/2 mins.	10	1	1	4
47.5° for 10 mins.	8	---	---	---
0.00008% colchicine continuously	15	3	---	---
0.00004% colchicine continuously	16	1	---	---
0.00041% colchicine continuously	21	2	2	1
0.00041% colchicine for 2 hrs. 30 mins.	12	1	---	---
0.0008% colchicine for 30 mins.	14	2	---	---
0.00016% colchicine continuously	8	1	2	1
0.00041% colchicine continuously	10	---	2	1

*May be triploid, chromosome number more than 48.

Summary

Dilute solutions of alcohol, ether, and colchicine or brief exposure to supranormal temperatures inhibit the normal cleavage rate of fertilized rabbit ova *in vitro*. Cytoplasmic fragmentation also occurs as the result of these treatments. The inhibition of cleavage and the rate of chromosome division are differentially affected so that in a number of instances tetraploid ova are formed. Colchicine appears to be especially effective not only in preventing spindle formation and cytoplasmic cleavage but also in inhibiting the normal movements of the pronuclei. The tetraploid ova of these experiments ordinarily failed to cleave over a period of one day's culture and the few that did cleave did so at a subnormal rate.

Literature Cited

1. Gregory, P. W. The early embryology of the rabbit. *Carnegie Inst. Wash. Contrib. to Embryol.* 21, 141. 1930.

2. Painter, T. S. Cell size and body size in rabbits. *Jour. Exp. Zool.*, 50, 441. 1928.

3. Pincus, G. The comparative behavior of mammalian eggs *in vivo* and *in vitro* IV. The development of fertilized and artificially activated rabbit eggs. *Jour. Exp. Zool.* 85, 82. 1939.

THE EFFECT OF POLYPLOIDY AND APOMIXIS ON THE EVOLUTION OF SPECIES IN CREPIS

G. L. Stebbins, Jr., and E. B. Babcock

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SEVENTY years ago Gregor Mendel attempted to give botanists a better understanding of the remarkable polymorphism among the hawkweeds, which comprise the genus Hieracium, by means of hybridization experiments. He found to his surprise and dismay that no matter how carefully he emasculated the tiny florets, they always yielded a large proportion of offspring that exactly resembled their maternal parent, and only a few hybrids could be obtained. Furthermore these hybrids did not segregate as did his hybrids of peas, but bred absolutely true to type. He concluded his work on Hieracium with the prophetic suggestion that the polymorphism of this genus might be due to the constancy with which the hybrids reproduce themselves.

Mendel had no way of knowing the reason for this anomalous hereditary behavior of the hawkweeds, but the results of a later generation of botanists, led by Strasburger, Juel, Ostenfeld, and Rosenberg, succeeded in demonstrating the cause of this phenomenon, and in establishing that reproduction and dispersal without fertilization, technically called apomixis, is a process that occurs regularly in many of the seed plants. During the last thirty years, the list of genera of seed plants in which this type of reproduction is known or suspected to occur in some form or other has increased to nearly thirty, so that we now realize that it is by no means a rare phenomenon. Familiar plant genera in which apomictic species or races are known include Poa, Calamagrostis and Buchloe in the grass family, Rubus (blackberry), Rosa, Malus (apple), Sorbus (mountain ash), and Potentilla (cinquefoil) in the Rose family, and Hieracium, Taraxacum (dandelion), Antennaria, Erigeron, and Arnica in the Compositae.

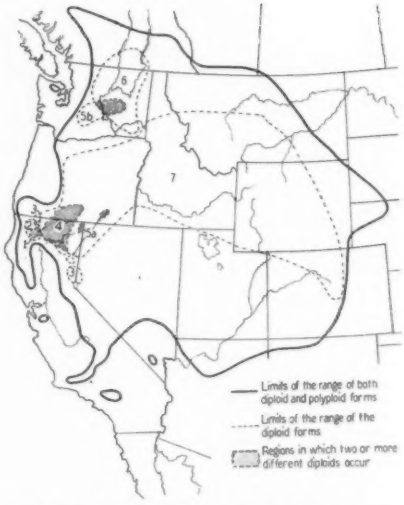
A further fact which has appeared as a result of the researches of the last forty years on apomixis in plants is that the presence of this type of reproduction is closely correlated with polyploidy and interspecific hybridization. Rosenberg[13] discovered that *Hieracium aurantiacum*, one of the objects of Mendel's researches, is a tetraploid, with the somatic chromosome number $2n = 36$, while the related sexual species, *H. auricula*, is diploid with $2n^* = 18$. Since then, most of the apomictic seed plants have been found to be polyploids, while their nearest sexual relatives are nearly always diploid.[14] Furthermore, as was first pointed out by Ernst,[6] most apomictic plants appear to be of hybrid origin, although apomictic non-hybrid polyploids, or autopolyploids, have also been reported by Bergman.[4]

The presence of apomixis coupled with polyploidy and hybridization has naturally a profound effect on heredity and evolution in the groups in which it occurs. In order to get a clear picture of these effects, the present authors have made a detailed study of a group of species in the genus Crepis in which apomixis, polyploidy, and hybridization are predominant. The species involved include only a small portion of the genus as a whole, which are confined to the arid hills, mountain slopes, and sagebrush plains of western North America.

*The symbols n and x are here used, following the usage of most cytologists, in the following manner. The letter n represents the reduced chromosome number of a particular plant, the symbol $2n$ its unreduced, or somatic number. The letter x indicates the basic haploid number for the group as a whole, while $2x$, $3x$, $4x$, etc., are used to designate the particular multiple of this basic number that exists as the somatic number of any particular species or race.

Some years ago Hollingshead and Babcock[8] found that the basic chromosome number for these species is $x = 11$, while they further showed that within each species, as recognized by systematists, are found races with somatic numbers varying from $2n = 22$ up through 33, 44, and 55 to $2n = 88$. The presence of many wild races with the uneven, "unbalanced" somatic numbers 33 and 55 led to the first suspicions that apomixis occurs in these species. The present authors have not only confirmed these suspicions, but in addition have been able, by careful study of all of the species of this group, to outline the effects that apomixis, polyploidy, and hybridization have had on its evolutionary history.[3] Like all groups with apomixis, these species show a high degree of polymorphism, which has made them very puzzling to the systematic botanist.

Within the group seven diploid, purely sexual forms have been found. These are all strikingly different from each other both in their outward appearance and their geographic distribution, and unquestionably represent seven distinct species. With one exception, diploid *Crepis acuminata*, these diploids are restricted in their geographic distribution to a small portion of the range of the group as a whole, and some of them are very rare. The polyploids occur abundantly, for the most part, along with the diploid forms, and in addition extend far beyond the limits of the ranges of these diploids. The contrast between the extent of the diploids and their related polyploids is illustrated in Figure 3. The data for this figure were compiled partly from actual counts of chromosome numbers in root-tips, but much more extensively from measurements of stomatal size and determinations of the character of the pollen in herbarium specimens. The principle that polyploids usually have larger stomata than diploids is now familiar to cytologists,[15] and holds very well in Crepis. In fact, several predictions of chromosome numbers made on this basis have been verified by actual counts, and all the errors in prediction, except in a few cases in which the material was inadequate, have been merely



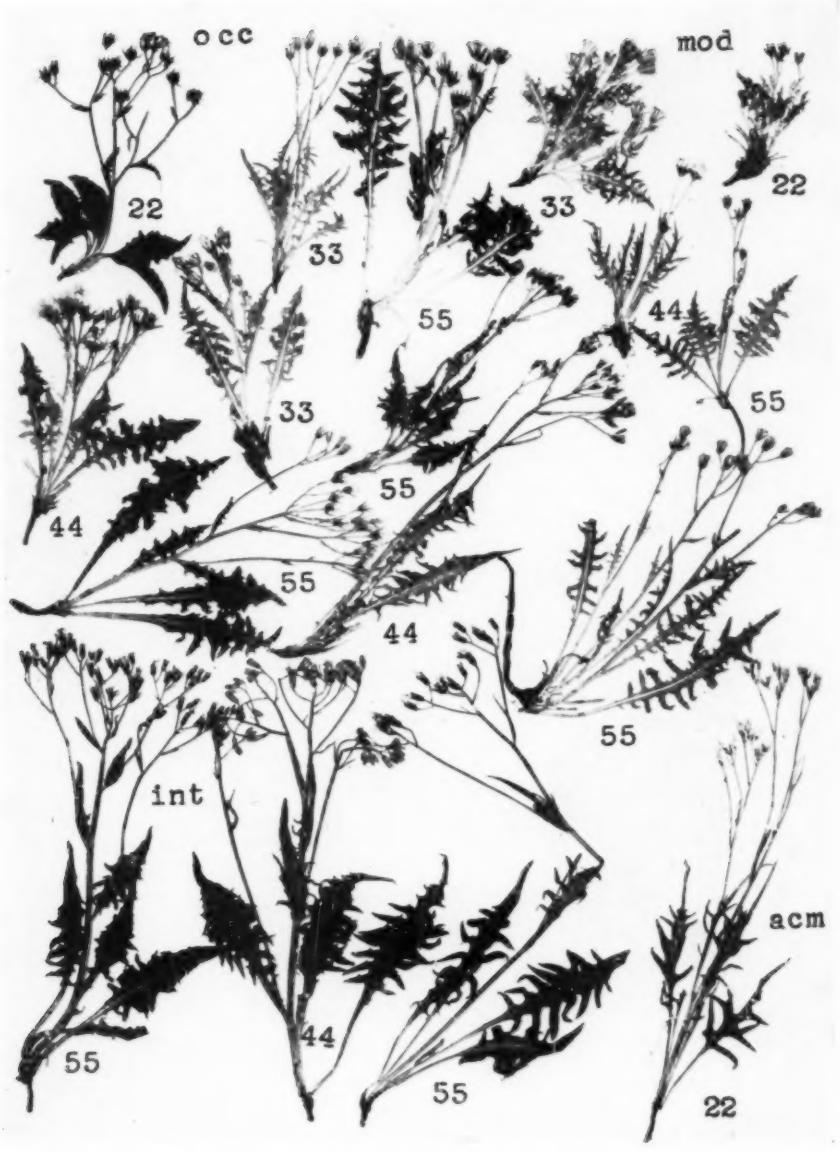
POLYPLOIDS MORE WIDESPREAD THAN DIPLOIDS

Figure 3

Map showing the distribution of diploid and related polyploid forms of *Crepis* in North America. The ranges of the diploid species are numbered as follows: 1. *C. pleurocarpa* Gray; 2. *C. monticola* Cov.; 3. *C. occidentalis* Nutt.; 4. *C. Bakeri* Greene; 5a, 5b. *C. modocensis* Greene subspp. *typica* and *rostrata*; 6. *C. exilis* Osterhout; 7. *C. acuminata* Nutt.

in determining the degree of polyploidy. The amount of irregularity in the pollen, as well as the number of germinal pores present, have been helpful as additional criteria in many cases.

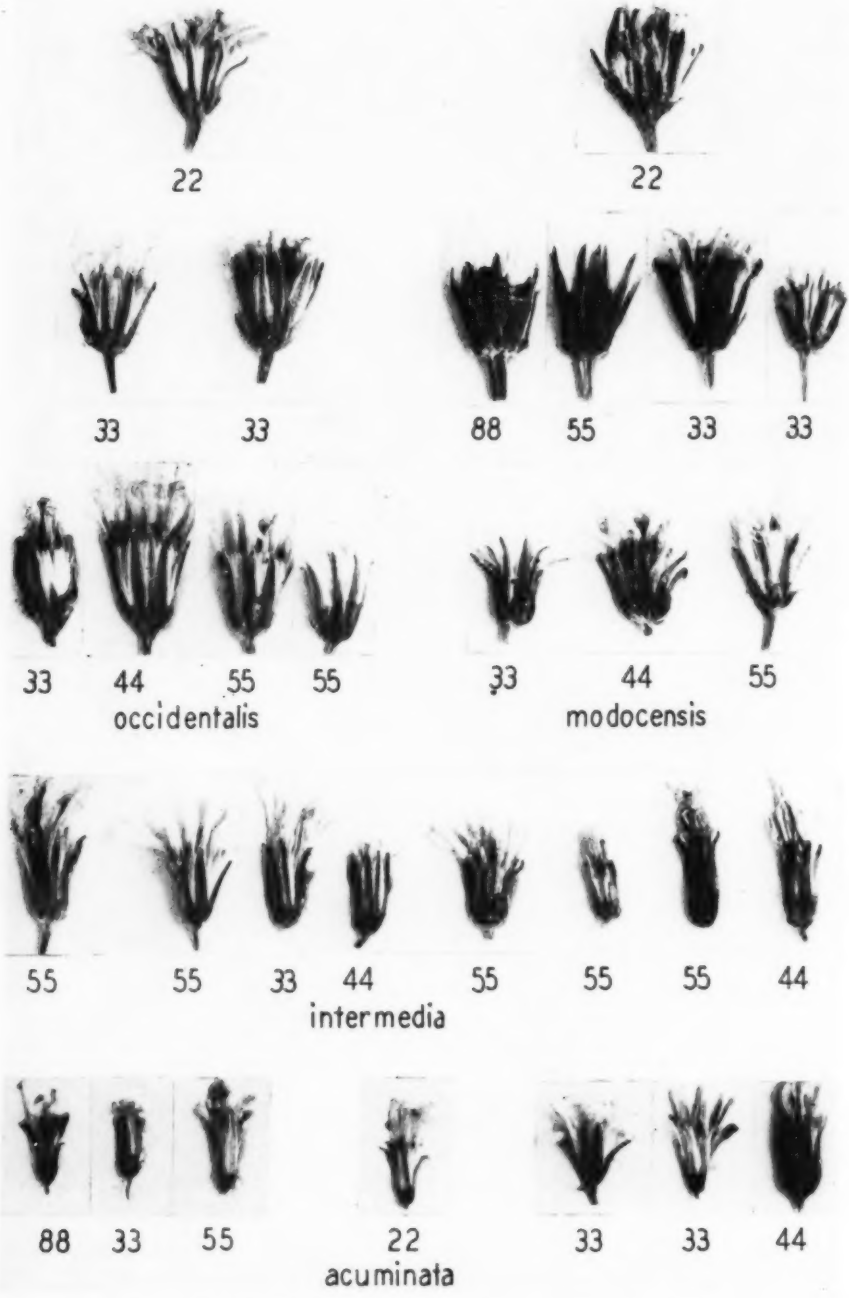
In order to demonstrate the interrelationships between the diploid and the polyploid members of this complex, three of the diploid forms and their polyploid relatives have been here selected for a particular discussion. These three diploids are included under the species *Crepis occidentalis* Nutt., *C. modocensis* Greene subsp. *typica* Babcock and Stebbins, and *C. acuminata* Nutt. Figure 4 shows the difference in general appearance between these three, while the difference between them in the morphology of their flower heads and achenes are shown in Figures 5 and 7. These figures show how widely different in every respect these three forms are from each other. Although the difficulty of grow-



POLYPLOIDS ARE INTERMEDIATE BETWEEN THEIR DIPLOID RELATIVES

Figure 4

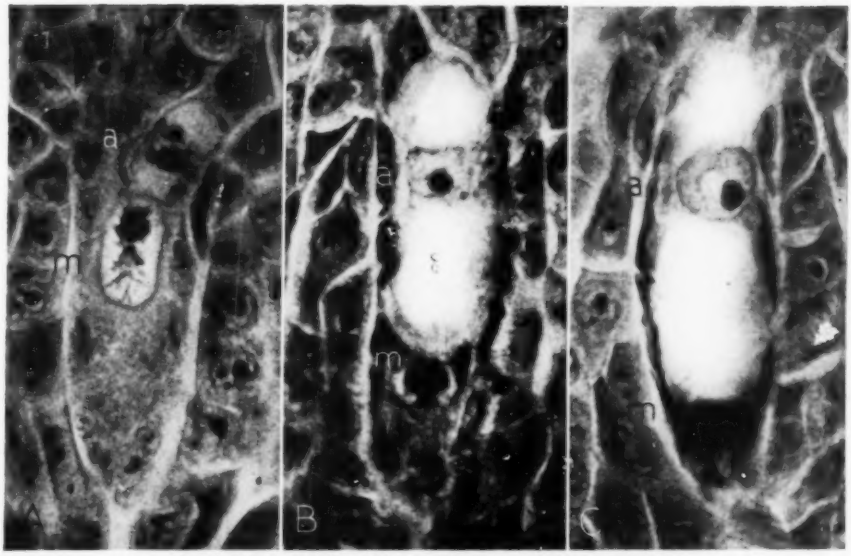
Photographs of herbarium specimens of diploid *Crepis occidentalis* (upper left), *C. modocensis* (upper right), and *C. acuminata* (lower right), and of various polyploid, apomictic forms derived from them. The numbers indicate the probable somatic chromosome number of each plant. About 1/7 natural size.



THE FLOWERING HEADS ARE ALSO INTERMEDIATE

Figure 5

Flower heads from plants corresponding to those illustrated in Figure 4. About natural size.



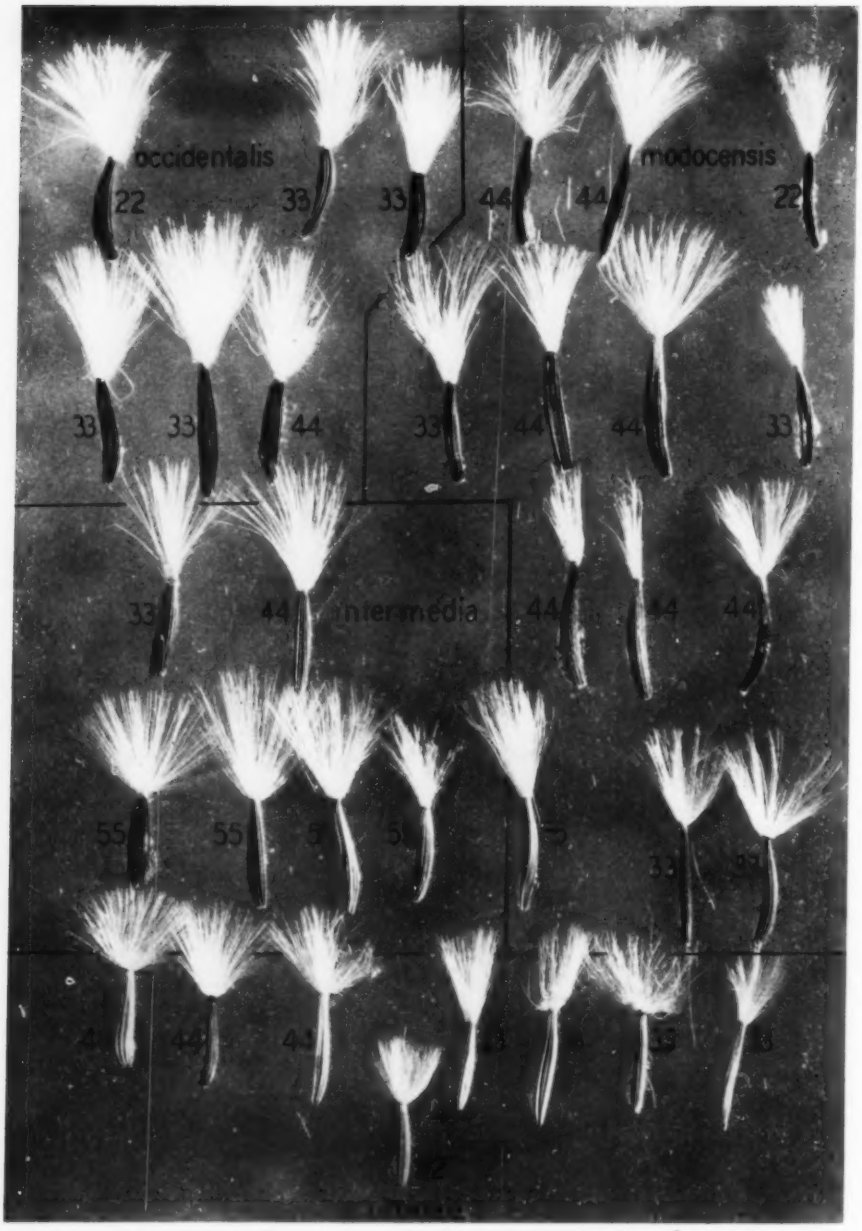
APOSPORY REPLACING NORMAL DEVELOPMENT

Figure 6

Photomicrographs of three different ovules from the same head of an apomictic form of *Crepis modocensis*, showing progressive stages in the crushing of the megaspore mother cell by a rapidly growing, aposporic cell from the somatic tissue of the ovule. Magnification 750 ×.

ing them under cultivation has made hybridization between them impossible, the evidence from crosses between Old World species of Crepis suggests strongly that forms as different from each other as these three would give sterile F_1 hybrids. The most distinctive features of these diploids, in addition to the gross features of size, leaf shape, and number of flower heads, which are evident from Figure 4, are as follows. Diploid *C. occidentalis* has the stems, leaves, and involucres covered with a dense grayish woolly tomentum interspersed with small glandular hairs; the outer bracts of the involucre are about one-fourth to one-half as long as the inner ones; its heads have 15—30 florets, while the achene is reddish, thick, and very strongly ribbed. In diploid *C. modocensis* subsp. *typica* the stems, leaves, and involucres have very little tomentum on them, but are covered with long, glandless bristles or setae; its outer involucral bracts are somewhat longer than those of *C. occidentalis;* the number of florets per head varies from 22 to 35; while the achenes are blackish or greenish, rather slender, and hardly at all ribbed. *C. acuminata*, on the other hand, has the stems and leaves tomentose like those of *C. occidentalis*, but not glandular; the involucres are smooth and shining; its outer involucral bracts are very short; the heads are much smaller than those of *C. occidentalis* and *C. modocensis*, and contain only five or six, or less often seven to ten florets; and the achenes are pale buff or straw-colored, somewhat slender, and indistinctly ribbed.

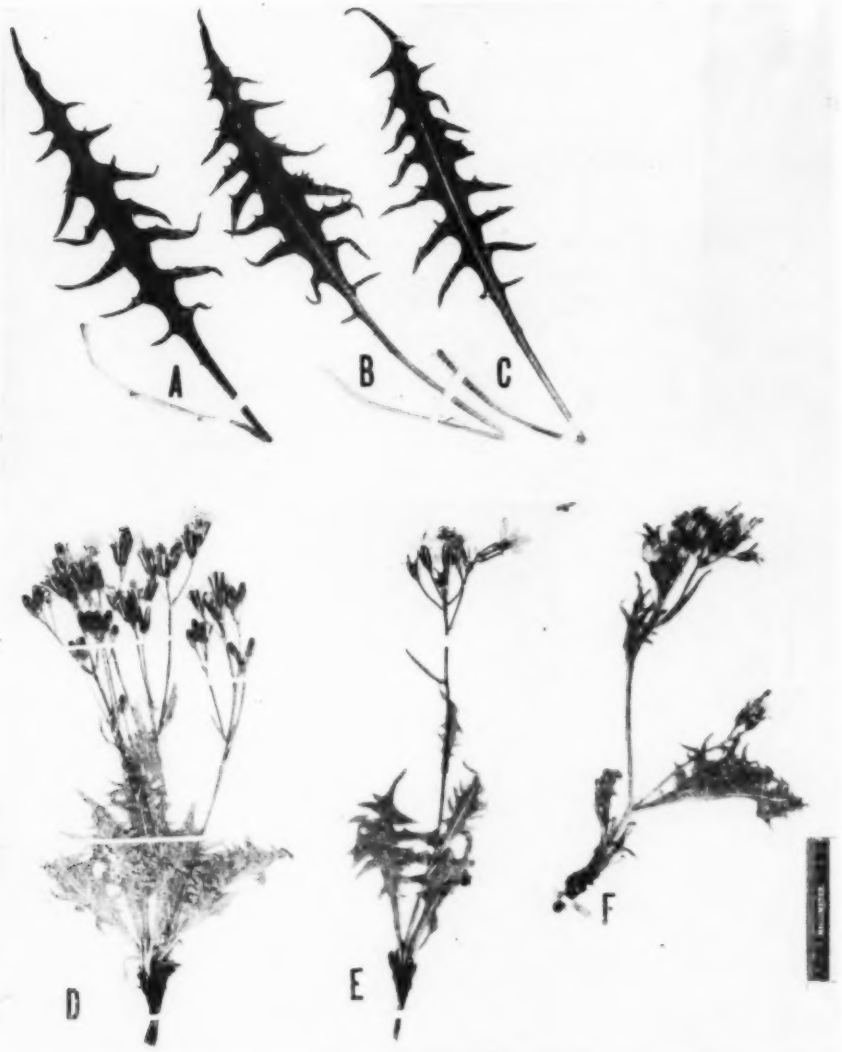
The polyploid, partly or wholly apomictic forms are of two general types in regard to their external morphology. Some of them look exactly like the diploids, except that they are sometimes larger. These may be considered as autopolyploids, which appear to have arisen from the diploids simply by the multiplication of the chromosome number. They are in the minority, however. The large majority of the polyploid, apomictic races of Crepis combine in one way or another



THE COMPARISON EXTENDS TO THE ACHENES

Figure 7

Achenes from plants corresponding to those in Figures 4 and 5. About twice natural size.

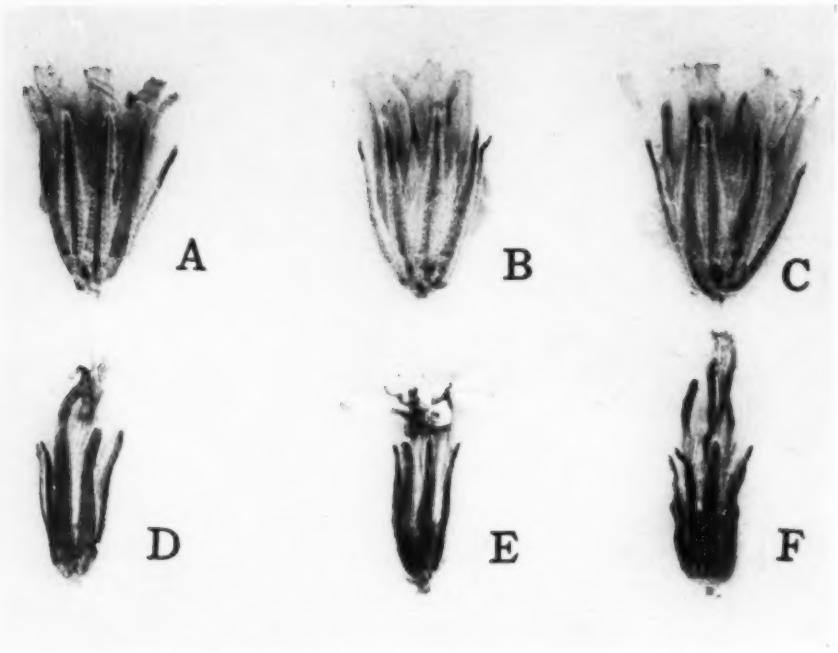


TWO SETS OF IDENTICAL TRIPLETS

Figure 8

A, B, C, Leaves of three different plants of the same apomictic form of *Crepis intermedia* Gray found in different localities in north-central California. *D, E, F,* Herbarium specimens of three different plants of another apomict of *C. intermedia* found in different localities in the Sierra Nevada. Since these strains are reproduced by buds of maternal tissue invading the embryo-sac, each apomict is genetically identical. About 3/8 natural size.

the characteristics of two or more of the diploid forms. Furthermore, they form a complete series of intergradations between the various diploid forms, so that one cannot draw a line between the forms more closely related to one diploid and those nearest to another. The extent of this intergradation in every single morphological characteristic is partly illustrated by the series of polyploid



THE FLOWERING HEADS ALSO IDENTICAL

Figure 9

Flowering heads of the same plants as those illustrated in Figure 6. About 1½ times natural size. The astonishing intra-strain similarity is obvious.

apomicts shown in Figures 4, 5, and 7, and is discussed by the authors in detail elsewhere.[3] Furthermore, although each diploid form possesses certain morphological features not found in any other diploid of this group, such as the bristles of *C. modocensis* and the smooth, shining involucres of C. *acuminata*, there are no such distinctive characteristics among the polyploid apomicts. *The morphological characteristics of all of the polyploids can be explained on the basis either of the increase of size through multiplication of the chromosome number, or through the combination of characteristics derived from different diploids.* Morphologically all of them are either auto- or allopolyploids; there are no "new," or divergent forms among them.

The polyploid apomicts combine not only the morphological characteristics of different diploid forms, but also in all probability the physiological and ecological characteristics that govern their geographic distribution. Analyses of the distribution of certain of these polyploids suggests this possibility, and along with it the likelihood that this type of recombination is largely responsible for the wide distribution of the polyploid as compared with the diploid forms. This point is well illustrated by the two apomicts which are found on the Mt. Hamilton Range in west central California. The position of this range is marked in Figure 3 by a circle just southeast of San Francisco Bay. As this map shows, Mt. Hamilton is an outlying locality for Crepis, 150 miles away from the edge of the continuous range of the genus. Its climate is semi-arid, and rather mild. Of the two Crepis apomicts found there, one combines the morphological characteristics of diploid *C. occidentalis* and diploid *C. pleurocarpa*, while the other is intermedi-

ate between the diploid forms of *C. occidentalis* and *C. monticola*. Diploid *C. occidentalis* occurs principally on the desert mountain ranges and valley terraces on the northeast side of the Sierra Nevada (cf. 3 in Figure 3), where the climate is as dry as or drier than that of Mt. Hamilton, but is much colder, due to the altitude. Diploid *C. pleurocarpa* and *C. monticola*, on the other hand (1 and 2 in Figure 3), are found in the Klamath Mountains of Northern California, which have a much less arid climate than that of Mt. Hamilton, but one which is nearly as mild, and certainly less severe than that occupied by *C. occidentalis*. These facts strongly suggest, therefore, that the Crepis apomicts on Mt. Hamilton have been able to combine the resistance to dryness found in *C. occidentalis* with the tolerance of a mild climate found in *C. pleurocarpa* and *C. monticola*. By this means they have been able to spread beyond the range of either of their diploid relatives.

In their method of reproduction, as well as in their external polymorphism, the polyploid Crepis apomicts resemble closely those of Hieracium, subgenus Pilosella. This reproductive process is a type of apomixis known as somatic apospory followed by parthenogenesis[14, 16] and was first described in Hieracium by Rosenberg. Detailed studies in Crepis made by the junior author and Dr. J. A. Jenkins[16] may be outlined as follows:

In the young ovules, the megaspore mother cell enters the prophase of meiosis just as it does in the normal, sexual forms and, if left undisturbed, goes through two meiotic divisions which produce four megaspores, each with the reduced (n) number of chromosomes. One of these megaspores may then give rise in the normal manner to an embryo sac and an egg cell, also with n chromosomes. At various stages of this development, however, one or more of the somatic nuclei next to the developing megaspores or embryo sac may begin to enlarge independently. Often one of these nuclei, with its surrounding cytoplasm and rapidly growing vacuoles, actually invades the megaspore mother cell, and crushes its nucleus (Figure 6). These somatic nuclei then increase in size, and finally produce a more or less normal embryo sac, of which all of the nuclei, including the egg, have the unreduced ($2n$) number of chromosomes. Such egg nuclei can produce embryos parthenogenetically, without fertilization. In fact one can usually find, by sectioning unopened buds of these Crepis forms, young embryos already developing. In some cases the growth of the somatic nucleus does not hinder the development of the normal embryo sac. This results in the formation within the same ovule of two embryo sacs, one with the reduced and one with the unreduced number of chromosomes. In all but one of the forms examined cytologically, at least some ovules were found with no sign of the aposporic development of an embryo sac from a somatic nucleus. Since the normal embryo sacs in these ovules could be fertilized in the usual manner, most of the Crepis apomicts could be expected to produce, along with a large number of apomictic progeny identical with themselves, a few sexual offspring. These offspring, whether they were the result of selfing or of outcrossing, would contain different gene combinations, and hence would differ in appearance from their parent. They would in turn reproduce largely by apomixis, and therefore would represent the beginnings of new apomictic forms or "clones." These are exactly the genetic results obtained by Ostenfeld[12] in his experiments with Hieracium (subgenus Pilosella).

On the basis of this evidence, we may now construct an outline of the probable evolutionary history of these species. The seven diploids may have arisen from a common 11-paired ancestor, or they may each have originated independently from different species of Crepis. The latter hypothesis is the most likely one, since each of the different diploids finds its counterpart in one or two species of Eastern Asia. The Asiatic species are now quite distinct from each other, and some of them are not even closely related. Their basic chromosome numbers are $x = 4$ and $x = 7$, indicating that the "diploids" of the New World with $x = 11$ are themselves allopolyploids derived from hybridization of four- and seven-paired Old World species, as was first suggested by Hollingshead and Babcock.[8] The origin of the American diploid species was probably in middle or late Tertiary time, as is indicated by several lines of evidence.[3]

Soon after the diploids reached Western North America, two processes began. In the first place, they hybridized, to produce more or less sterile F_1 progeny. At the same time they may have produced autopolyploid offspring by means of somatic doubling or through the production of unreduced gametes. Then, by means of chromosome doubling in the

diploid F_1 hybrids, or by hybridization between autopolyploids of two different species, or between the autopolyploid of one species and the diploid of another, the various intermediate allopolyploids illustrated in Figures 4, 5, and 7 were produced. We cannot tell now which of these processes was most important in producing the Crepis allopolyploids; they may all have been equally important. The production of allopolyploids by hybridization with subsequent doubling is now a well established process of cytogenetics; Darlington[5] lists (in his Table 26) forty-nine cases of experimentally produced allopolyploids. The synthesis of a widespread Linnaean species by means of allopolyploidy was accomplished by Müntzing[10] for *Galeopsis Tetrahit* while the allopolyploid origin of *Spartina Townsendii* (Huskins[9]), *Iris versicolor*[2], and several other well known species is well established on morphological and cytological evidence. There are no cases on record of the production of allopolyploids by means of the hybridization of two different autopolyploids, but this process could undoubtedly occur, and should lead to the same results as hybridization followed by doubling.

There is no direct evidence as to how the polyploid forms of Crepis became apomictic. The fact that apomixis is strongly developed in some forms which, judging from the evidence of external morphology, are autopolyploids, is evidence against the hypothesis of Ernst[6] that hybridization is the cause of apomixis. Gustafsson[7] has pointed out that the experimental results of Lidforss, involving hybrids between sexual and apomictic blackberries, Rubus, can best be explained on the basis that apomixis "is conditioned by a series of recessive factors." The work of Ostenfeld[12] on Hieracium points in the same direction. Hybridization probably is simply an accompanying phenomenon of apomixis.[7,16] The great predominance of allopolyploids among apomictic forms can be explained in several ways. In the first place, the "hybrid vigor" of many of the allopolyploids would give them a high survival value. Secondly, by means of the recombination of morphological and physiological characteristics of two different diploids, many of these allopolyploids, as mentioned above, can become adapted to a new ecological niche, and therefore migrate into an area not yet occupied by any of their relatives. Finally a large series of allopolyploids, those with uneven chromosome numbers, would be subjected to a rigid selection for apomixis, since the individuals which did not have this method of reproduction would be unable to reproduce themselves on account of their sterility. Another reason why hybridism and apomixis usualily occur together may be that apomixis is often produced by the action of complementary genes in interspecific hybrids, but as yet we have no evidence on this point.

The close association between polyploidy and apomixis in plants is undoubtedly of some significance. Müntzing[11] has emphasized the fact that the physiological reactions, both external and internal, of polyploids are very different from those of diploids. It is likely, therefore, that the condition of polyploidy is one which favors the action of the genes or gene complexes that produce apomixis. On this point, also, experimental data are needed.

The final history of these Crepis species probably involved the further elaboration of apomictic forms. Since the majority of those now extant can produce a small percentage of sexual offspring,[16] they can still hybridize with each other to produce new apomictic forms. Many of these secondarily derived types appear to be backcrosses between the original allopolyploids and their ancestral diploids; others are apparently the result of outcrossing to a third or fourth species. The phylogenetic "tree" of these Crepis species is undoubtedly a very complex network of interlacing branches, such as Anderson[1] has postulated to exist in the genus Iris.

As the different apomictic forms of this complex were produced, they were subjected to a rigid selection by the environment, and only those forms which were fitted to occupy some ecological niche in the region where they found themselves were able to survive. The re-

sults of this selection are very evident in the pattern of variation found in the group throughout its range. In northeastern California, which is occupied by several different sexual diploid species of Crepis, there are literally hundreds of apomictic forms, and there may be a dozen or more within a colony not more than a half acre in extent. Near the edge of the range of the group the number of apomicts found is very small. Only a few have been able to spread far beyond the place where they originated. Furthermore in these remote areas each colony is remarkably uniform; its individuals are all "identical twins." In fact, we have found that plants collected twenty, fifty, or even a hundred or more miles apart in Central and Southern California, Arizona, Colorado, or Wyoming, are literally indistinguishable from each other. Furthermore, forms which are nearly like one or other of the sexual types are found almost exclusively within or near the range of the latter. On the other hand, the apomicts which have found their way to the limits of the range of Crepis combine the characteristics of two, three or perhaps more different sexual types. They have evidently passed through more than one generation of recombination and selection.

Figure 8 (top) shows the leaves of three different plants of an apomictic form of *Crepis intermedia* Gray found in three different localities separated from each other by a distance of 10 to 15 miles, in Lake County, north central California. At each place the entire population of one to two hundred plants showed no more variation than the three individuals photographed. The involucres of the same plants are shown in Figure 9, *A*, *B*, and *C*. This form is pentaploid ($2n = 55$), and produces very irregular pollen. In the bottom row of Figures 8 and 9 are shown the whole plants and separate involucres of three different individuals representing an apomictic form of *Crepis intermedia* that occurs on the upper slopes of the Sierra Nevada at altitudes of 8,000 to 11,000 feet, higher than any other form of Crepis belonging to this group. The left hand plant (*D*) was collected in the northern Sierra Nevadas; the right hand one in the central part of the range, 120 miles farther south, while the middle one (*E*) grew 170 miles away from the locality of (*F*). This apomictic form is probably tetraploid, and produces no pollen whatever. It is probably an allopolyploid derivative of three different diploids, *C. acuminata*, *C. occidentalis*, and *C. modocensis*.

This analysis of the apomictic species of Crepis is an attempt to correlate the recent discoveries of cytogenetics with the patterns of variation that we find in nature. Much more experimental work needs to be done before such correlations can be put on a really firm basis, but if we make such studies from time to time, basing them on all the available facts and always admitting the weaknesses, we can find out how nearly we have come to discovering the cytogenetic basis of evolution, and can give new purpose and vigor to our efforts in that direction.

Literature Cited

1. Anderson, E. Internal factors affecting discontinuity between species. *Am. Nat.* 65: 144-148. 1931.
2. ————. The species problem in Iris. *Ann. Mo. Bot. Gard.* 23:457-509. 1936.
3. Babcock, E. B., and G. L. Stebbins, Jr. The American species of Crepis: their relationships and distribution as affected by polyploidy and apomixis. *Carnegie Inst. Wash. Pub. No. 504.* 200 pp. 1938.
4. Bergman, B. Zytologische Studien über sexuelles und asexuelles *Hieracium umbellatum*. *Hereditas* 20:47-64. 1934.
5. Darlington, C. D. Recent Advances in Cytology, second edition. London, 1937.
6. Ernst, A. Bastardierung als Ursache der Apogamie im Pflanzenreich. Jena, 1918.
7. Gustafsson, A. Studies on the mechanism of parthenogenesis. *Hereditas* 21:1-112. 1935.
8. Hollingshead, L., and E. B. Babcock. Chromosomes and Phylogeny in Crepis. *Univ. Calif. Publ. Agr. Sci.* 6:1-53. 1930.
9. Huskins, C. L. Origin of *Spartina Townsendii*. *Genetics* 12:531-538. 1931.
10. Müntzing, A. Uber Chromosomenvermehrung in Galeopsis—Kreuzengen und ihre phylogenetische Bedeutung. *Hereditas* 14:153-172. 1930.
11. ————. The evolutionary significance of polyploidy. *Hereditas* 21:263-378. 1936.
12. Ostenfeld, C. H. Further studies on the apogamy and hybridization of the Hieracia. *Zeitschr. Ind. Abst. u. Vererbungsl.* 3:241-285. 1910.

13. Rosenberg, O. Cytological studies on the apogamy in Hieracium. *Bot. Tidsskr.* 28:143-170. 1907.

14. ————. Apogamie und Parthenogenesis bei Pflanzen. *Handb. der Vererbungswiss.* 2. 1930.

15. Sax, K., and H. J. Sax. Stomata size and distribution in diploid and polyploid plants. *Journ. Arn. Arb.* 18:164-172. 1937.

16. Stebbins, G. L., Jr., and J. A. Jenkins. Aposporic development in the North American species of Crepis. *Genetica,* 21: 191-224, 1939.

A NOTE ON THE RELATION OF *GOSSYPIUM RAIMONDII* ULBRICH

To Other American Species

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Ulbrich[1] has described *Gossypium Raimondii* suggesting that it is closely related to *G. Klotzschianum* of the Galapagos Islands. He also feels that it may be a wild form of *G. peruvianum.*

Chromosome counts showing the haploid number to be 13 were made at the Cotton Research Station, Trinidad, on material obtained from the Peruvian Department of Agriculture. This places it with the 13 chromosomed Pacific Wild species. On morphological grounds it would seem that *G. Raimondii* is more closely related to *G. Klotzschianum* and *G. Davidsonii* than to *G. armourianum, G. aridum,* and *G. Harknesii.*

G. peruvianum, however, belongs to the South American group ($2n = 26$) now known as *G. barbadense.* If *G. Raimondii* is a wild parent form of *G. peruvianum,* it would be expected that the whole group arose from this form.

In Ulbrich's description, which is entirely from herbarium material, it is said that the leaves are large, lobeless, heart shaped, and softly tomentose. The bracts are moderately small and deeply cut, and the flowers are the largest in the whole genus, being from 1 to 16 cm. in diameter. The whole surface of the stem is somewhat tomentose but three particularly hairy streaks may be observed to run downward from the base of each leaf giving the stem an angular appearance. The central streak comes from the base of the petiole and the outer two from the base of the stipules. This is considered the most critical character for purposes of identification.

From our own observation on living material it may be said that the younger parts of the stem are actually angular, and that the older portions are round but appear angular because of the streaks. The fresh flowers are cream colored with large, deep purplish red petal spots. The stamina tube is yellow and the filaments are similar in color to the petal spots. The pistil is white and unusually long. Pollen color is yellow. The scanty, dark greyish-green lint is firmly attached to the seed, and has a maximum halo length of 12-15 mm.

Wille et al[2] state that the distribution of *G. Raimondii* is confined chiefly to the valleys of Jequetepeque and Chicama, North Peru, where it harbors the insect pest *Dysdercus ruficollis.*

Ulbrich has compared the leaves with those of *G. Klotzschianum,* stating that the latter were more or less trilobed. As *G. Klotzschianum* has strictly entire leaves it is felt that Ulbrich may have confused it with *G. Darwinii,* the other species occurring in the Galapagos Islands.

I am indebted to Mr. Madoo for the chromosome preparations used in the study, and to the Empire Cotton Growing Corporation for the facilities.

Literature Cited

1. Ulbrich, E. Malvaceae americanae, imprimis andinae novae vel rariores. *Notizblatt des Bot. Gart. u. Mus. Berlin-Dahlem* 11:549-550. 1932.

2. Wille, J. E., J. L. Carrera, and L. Tijero. El Arrebiatado y ostro insectos daninos al algodonero los Valles del Norte del Peru. *Boletin No. 9* Estacion Experimental Agricola de la Molina, Peru. Pp. 21-23. 1932.

TWO MEYER MEDALS AWARDED DURING 1939

Kate Sessions and David Fairchild Cited for Plant Introduction Achievements

DURING 1939 the Council of the American Genetic Association awarded Meyer Medals to Miss Kate Sessions of San Diego, California, for her outstanding contributions to the horticulture of her native state, and to Dr. David Fairchild, veteran plant explorer whose interests and activities are well known to members of this Association. The Meyer Medal was established in 1919 through a bequest by the late Frank Meyer, pioneer plant explorer of the office of Foreign Seed and Plant Introduction of the U. S. Department of Agriculture.*

For many years, David Fairchild has been the logical person to receive a medal for the purpose for which the Meyer Medal was established. His close association with both the office of Foreign Plant Introduction of the Department of Agriculture and with the American Genetic Association, made an award so close home somewhat of a problem. It was felt by the Council, however, that the medal could very properly be presented to signalize the fiftieth anniversary of Dr. Fairchild's connection with the Department of Agriculture, which occurred in July, 1939.

The presentation of the Meyer Medal to Miss Sessions took place at the Southern California Spring Flower Show held at Pasadena, April 1-3. It was made by Knowles Ryerson, of the University of California, formerly associated with the Division of Plant Introduction. Miss Sessions, who is 82 years old, has contributed greatly to the horticultural beauty of Southern California through fifty years of active work spent there as a landscape gardener and horticulturist.

She was born in San Francisco and graduated from the University of California in 1881. She taught in the schools of Oakland for a year or so and then moved South to San Diego where she became Vice-principal of the High School. Later she started a nursery business,—a very fortunate thing for the state and particularly for the city of San Diego as she brought to her new profession a deep and abiding affection for growing things, and a passionate love of beauty in all its forms, together with a fine conception of harmony in landscape design and planting.

For several years Miss Sessions conducted her nursery in Balboa Park and in consideration of this planted every year a number of trees grown by herself in the park. She is considered to be largely instrumental in making this great 1400-acre park the beauty spot it is. She afterwards moved her establishment to Mission Hills, and finally to her present location at Pacific Beach, where she has now been for more than twenty years. During all this time she has exercised her faculties to the fullest extent in absorbing and imparting horticultural knowledge, being a member of the extension faculty of the University of Southern California. She has lost no opportunity to bring to her city those various plants she considered would thrive and adorn its parks and gardens. She was mainly responsible for bringing in the original plants of *Cocos plumosa* and the fine specimens in the San Diego Plaza were planted by her. She was one of the first—if not the first—to plant *Bougainvillea spectabilis var. lateritia*, which covers so many of the houses and walls of her city with a riot of color. She first brought to public attention *Ceanothus cyaneus* and was also responsible for the planting of the Succulent Garden in Balboa Park. She is also credited

*For an account of the origin of the Meyer Medal see *Journal of Heredity* 11: 168-173, 1920.

with the introduction of the cork oak, the camphor tree, and several species of Eucalyptus and Acacia.

Miss Sessions also introduced several palms, of which *Erythea brandegeei* now widely distributed in California is probably the most important. Palms were discovered growing at Cape St. Lucas in Lower California by Mr. T. S. Brandegee, who recognized that one species was new to botanists. Miss Sessions organized an expedition to get this palm, which she believed would grow well in San Diego. She returned with three plants and a supply of seeds. One of the plants she kept. One she sent to the University of California, and one she gave to Mr. Brandegee who shared in the expenses of the expedition.

In 1925 Miss Sessions visited Italy. From the La Mortola Botanic Gardens at Veutimiglia she secured many seeds and a choice assortment of mesembryanthemums, aloes and agaves. These have added to the beauty of her native California.

The people of San Diego owe to Miss Sessions a debt that they can never repay. Her influence has made their town lovely and gracious, and has undoubtedly affected the lives and character of the people living there. Long after she is gone, the good she has done will live after her; nor will those who know and live near her ever forget her. The pleasant and flowery streets and ways of San Diego show her handiwork, and all the wealth of flowering trees, and shrubs she has planted are her enduring monument. She has dedicated her genius and energy to the principle of leaving her community a legacy of beauty and making life itself more serene and beautiful.

Surprise Award to Dr. Fairchild

The award to Dr. Fairchild was made at a surprise presentation on July 24, at the Plant Introduction Station at Glendale, Md. On account of Dr. Fairchild's close connection both with the Department of Agriculture and with this organization, the decision to present the Meyer Medal to him had been kept secret. Very fortunately Dr. Fairchild happened to pass through Washington at just the right time. The Secretary of Agriculture, the Hon. Henry A. Wallace, kindly consented to make the presentation for the Council of the American Genetic Association. Mr. Wallace's remarks on this occasion chronicle a few of the introductions made by Dr. Fairchild or inspired by his life-long enthusiasm for this work.

David Fairchild—Plant Explorer

Remarks by the Secretary of Agriculture, Hon. Henry A. Wallace, at the Presentation of the Meyer Medal to David Fairchild, at the Plant Introduction Station, Glendale, Maryland, July 24, 1939.

FIFTY years ago, in this same month of July, a shy young enthusiast from the plains of Kansas descended upon Washington to carve out a career in the newly awakening Department of Agriculture. The sword with which our hopeful youth proposed to open the bureaucratic oyster was a worthy blade — I quote: "As reading matter for the train, I had a highly technical description of a facultative parasite known as Macrosporium. This organism, under proper conditions, could cause the death of onion plants. I thought that facultative parasitism would be important in a civil service examination which I hoped to pass." This July, exactly half a century later, we have perhaps rashly, tried to stop this same youth, hastening as he has so often in the intervening years, to the ends of the earth to tend some distant corner of his world-wide garden. Your friends have warned me, David Fairchild, that if we were to mark the Jubilee anniversary of your first setting forth on your great adventure of plant exploration, we would have to do it on the fly. All of us here, and the host of your friends who are here in spirit only, are delighted that we have trapped you for a moment, to have a word with you about the work which has been your life.

What changes you have seen in those fifty

PRESENTATION TO MISS SESSIONS
Figure 10

In recognition of her distinguished service to American horticulture Miss Kate Sessions received the Meyer Medal on April 2, 1939, at San Diego, California.

years! You came to battle Macrosporium, to bring the onions of this land a more abundant life. From onions you went on to grapes, and, — traveling half way round the earth — to termites and to ants who have a mushroom industry all their own. Then a more compelling fate fell across your path. An angel with a flaming tongue, Barbour Lathrop, drove you from the peaceful Eden of laboratory notes and observations into a windy world of plants and people who must have plants to live, — and many plants to live abundantly.

The garden of your dreams has been not merely a pretty thing; it is woven into the very fabric of our lives. In fifty years so many things have gone completely, so many dreams have failed. But Barbour Lathrop's dream, and yours and that of the host of friends who have helped you on your way, that dream of taking what is good in the plants of all the earth to make our country better — this has grown as so many of your plants have grown, until today the plant explorer is accepted as a key man in building the agriculture of the future.

During this same time, a revolution has occurred in ways of breeding plants. This has profoundly changed and broadened the objectives of plant introduction. Genetics gives plant breeding sharp new tools, so that it is ceasing to be a botanical blindman's buff, and is rapidly becoming an exact science. The mechanism of inheritance is known, and we can to some extent build our varieties character by character, — plants made to order. This has shifted the emphasis in plant introduction from bigger and better varieties to be used as such, to a search for genes to shape adapted varieties to our needs. Such characters are often found in plants of little promise, that can be used to hybridize with the best cultivated varieties and by repeated large scale back-crossing yield disease-resistant superior forms. This means that agricultural explorers must often search for rare wild relatives easily overlooked, like the small grass-like species of Saccharum containing little sugar, yet highly resistant to the dreaded mosaic and other diseases of sugarcane. These wild species now appear in the pedigrees of all the best cane varieties grown all over the world. Yet the plant explorer would never have looked for them thirty years ago. This has meant a closer alliance between plant introduction and the formal botany of the taxonomists — for the hybrid-forming relatives of our crop plants are taking on a new importance. Increasing emphasis must be placed on a study of genetic relationships of the wild relatives of our major crops, for by this means we will save much time in making preliminary surveys of the tribes to which our cultivated plants belong.

Genes, Not Plants the New Need

A plant which of itself may have no beauty or apparent usefulness may be the basis of new industry or it may save the farmers of a region from being wiped out. We do not ask now: "Is it good to eat?" or "does it produce a long or tough fibre or a beautiful flower?" but "is it resistant to disease?" or "can it grow in alkali or on boron-poisoned soil?" "Can it flourish in the presence of such destroyers as rust, or powdery mildew?" A plant may offer nothing in the way of flavor or size or quality of fruit. If it has the one essential character of resistance to a disease threatening one of the plants we live by, it

may be the priceless genetic ingredient which will mean salvation to thousands of farmers and the safeguarding of an industry.

Thus in the irrigated valleys of the Southwest the cantaloupe industry fell ill, threatened with destruction by powdery mildew. An appeal went out for help, and to the plant explorers a call for resistant types wherever they might be found. One finally was brought to light in India. The melon was so small, so tasteless, and so subject to decay that it seemed a travesty to pin much hope onto it, but it was immune to this powdery mildew disease. Crossed with our own varieties, the hybrids were resistant too, but still were scarcely fit to eat. Back-crossed and re-back-crossed to commercial types, with selection of the hybrids showing resistance, finally gave us a mildew-resistant variety of excellent appearance and quality. The hybrid descendants of the unpromising plant immigrant from India are now on the Eastern markets, and the newer plant exploring had saved the day again.

So in the agriculture of the future, David Fairchild, your world-wide garden is going to take an increasingly important part. For through plant introduction, the plant breeder will have at his call not only the variability of the small sample in his own test plots but as many as possible of the changes in the genes that have taken place in an entire group of species throughout its distribution over wide areas and long periods of time. Thus the changes in living things which are going on over all the earth will be found and brought to serve mankind as they have never been before.

Life is constantly changing, and the rapid transport of these modern times has forced us to share not only the blessings but the pests of all the world. Hence the battle of the plant breeder always goes on, as he struggles against disease, — against changing conditions of soil and climate, and the shifting whims of human beings. Now he will have as his ally the tried old things which Nature has developed everywhere and the hopeful new things which Nature and the skill of man are bringing into being with the passing of the years.

New Plant Industries

Let us list a few of the multitude of gifts your dream has brought to all of us:

Durum wheat and red hard winter wheat, and many important oat varieties came directly or through selection from introductions, an important part of which your service sponsored. The Louisiana sugarcane industry was saved from ruin through the introduction of mosaic-resistant varieties, and subsequent improvements have been possible only because of further introductions, not of resistant varieties as such, but of wild species of saccharums often virtually lacking in sugar — but essential material for breeding mosaic resistance. The highly significant one-variety community cotton program owes much to the Acala variety, introduced from Mexico and improved in the United States. Over 1,000,000 acres of Acala cotton were grown in single variety communities in 1937.

The plant exploration and introduction work is now organized to coordinate with the needs of the other crop divisions in the Bureau of Plant Industry and with the State Agricultural Experiment Stations. The program is planned to obtain materials needed to meet important crop problems as they arise. Wilt-resistant alfalfas were obtained through the Plant Exploration and Introduction Division to meet the need when wilt threatened the alfalfa crop in the Middle West and West. The spread of wilt throughout the country has now made the importance of this contribution nation-wide. Grasses for forage and erosion control; lespedezas, badly needed as legume crops for southern agriculture; soybean exploration and introduction, which gave us a new American crop and new industries.

Fifty Years of Plant Introduction

(*See opposite page*)

In recognition of a lifetime devoted to plant introduction, the Myer Medal was presented to Dr. David Fairchild on July 24, at the Plant Introduction Station, Glendale, Maryland. Included in the photographs with Dr Fairchild and Secretary of Agriculture, Henry A. Wallace, are Mrs. Fairchild, and P. H. Dorsett, one of the other outstanding plant explorers of the Department of Agriculture. The background lists photographically a few plant introductions and plant introduction incidents. (Photo of presentation by *Science Service*.)

These are but a passing glimpse of what has been done by you or through the inspiration of your dreams.

And the instance could be multiplied. The introductions which you have made yourself, David Fairchild, have been legion. Merely to list them would keep you too long from that urgent date beyond a far horizon. And these plant godchildren of yours—that worthless Hindu melon which saved an industry—that lettuce seed which grew in spite of mildew and brown blight—these are all children of your dreams and mind and heart—just as much as those giant trees from half a world away which shade your house in Florida. And to the story of this government service in plant introduction must be added all you have done to marshall your friends outside into a great conspiracy of plant dissemination. A multitude have helped each according to his time and means. Several have done outstanding work. Barbour Lathrop's early inspiration has been mentioned. Later another friend, Allison Armour, helped greatly in your work in putting at your service for plant introduction the yacht *Utowana,* to the great enrichment of the plant group in Florida and the Southern States.

And recently your many friends led by Col. Robert Montgomery, in admiration of your energy, enthusiasm and devotion, have established a great collection of tropical plants at Coconut Grove not far from the Department's Plant Introduction Garden at Chapman Field. The Fairchild Tropical Garden, although founded less than a year and a half ago, already has a splendid collection of several hundred species of palms and other tropical plants. This and the Chapman Field garden constitute a rapidly growing collection of genes of the tropical relatives of our warm-temperate and subtropical crop plants that will be used increasingly by the plant breeders of the dozen Southern states that grow subtropical crops.

And you who are inclined to flee from crowds and masses of men will be glad, I think, that this brain-child of yours can never be captured in cities, or ever made just another bureau of our great Government. The work which you started, and which plays so large a part in the future of our lives is not a large organization as bureaus go today. The real essence of the work is here in this station where plants grow, and out over the land, wherever new plant immigrants are found to thrive. Those chosen men — six or eight at most — who search in far corners of the earth for new plants and for old plants with new characters, are the spearhead of the fight against the changing trends and ever-new dangers which afflict our farms. The conquest of these dangers must depend, in many cases, not in prevention or control but in resistance from within the plant itself.

And in speaking with you of these things we must remember too, many other pioneers who helped you break the trail. Some of them are here today: Waite, Ryerson, Westover, Swingle, Scofield, Dorsett, Kearney, Cook and Young. Many are gone—Lathrop, Meyer, Collins, Spillman and Galloway. All these and a multitude of others had their part in shaping this work which has been your life. And let me not forget another who is here today — Mrs. Fairchild — who has borne with fortitude the wanderings and the enthusiasms of a plant explorer — who has said through it all, we understand, "push on David, there are other plants beyond the seas."

And now endless enthusiast that you are, you are setting forth again to those Tropic Islands of the Java Seas which beckoned in your youth. Before you get away I have been asked by the Council of the American Genetic Association, acting as trustees for the staff of your own office of Plant Exploration and Introduction to present as a token of the heartfelt honor and affection which they have for you, this little Medal. It serves already as an unseen link between fifteen of the pioneers in this field. I know that you will say you are too close to its administration to receive it with propriety, and that such an award must embarrass you. But your objection is over-ruled in advance. After those fifty busy years, you have become a bit of a symbol, and symbols must sometimes accept what persons might avoid.

And so we wish you well as you hurry forth again to tend a distant corner of your far-flung garden. And from the islands of the tropic seas send us back, along with new plants for your beloved Florida, some answers for the many plant problems that are certain to be ahead. So we thank you for pausing a moment with us as you are setting forth again—and now, in the name of the plants you love, *push on!*

BEHAVIOR OF GENES IN INTER-GENERIC CROSSES

Effects of Two Dominant Genes on Color in Pheasant Hybrids

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HYBRIDIZATION has long been a recognized technique in the study of interrelations among plants and animals. Darwin[4] considered it one of the most dependable ways of inducing the reversions for which he was ever on the lookout and, although his basic concepts are not strictly in accord with those of the present, his records still furnish one of the most valuable sources of data on hybridization in birds. To Darwin's contributions have been added the extensive, but essentially pre-Mendelian, observations of Whitman and the results of a number of special studies such as those of Crew and Koller[2], Ghigi[5], Haig-Thomas and Huxley[7], Irwin[8], and Phillips[9]. Some of the findings are difficult to interpret on simple Mendelian grounds and the newer views on interaction of genes and evolution of dominance raise questions as to how a gene will behave in the milieu of genic and protoplasmic factors which are largely foreign. These problems led the writers to a further study of hybridization in the *Phasianidae*, a group in which there occurs a variety of form and color traits. The present report is limited chiefly to observations on the expression of two genes, one for dominant white in *Gallus*, the other for the *tenebrosus*, or mutant, complex in *Phasianus*. The effects of the mutant gene in varietal crosses within the genus where it first arose are discussed by Bruckner[1] in earlier pages (45-52) of this volume of the JOURNAL.

The *W* Gene in *Gallus domesticus*

The gene (*W*) for dominant white is presumably an ancient one. When it first appeared is difficult to say, since white fowls recorded in early times may have been either recessives or dominants. Darwin (Vol. I, p. 292) was obviously dealing with dominant white in his cross between a white game hen and a black Spanish cock, from which he obtained two white chicks both of which later acquired some yellow color, one even simulating the coloring of a red pile gamecock. In commenting on this Darwin quoted his contemporary, Mr. Tegetmeier, to the effect that by crossing black breasted reds with white games he could obtain red piles (i.e., white birds with red markings) at will. This is in accord with what we know today. Stated briefly, the gene for dominant white when homozygous completely suppresses the production of black pigment. When heterozygous it is less effective, permitting occasional black or flecked feathers to appear. With respect to yellow it is much weaker in its effect, generally allowing this color to show through with only a moderate reduction in intensity[3].

In the down plumage, birds homozygous for *W* and for black (as contrasted with yellow) are generally pure creamy white without dark markings. Those otherwise the same but heterozygous for *W* are creamy or chalky white with a few black or gray flecks. Those that carry yellow usually show a definitely buffy cast.

The *M* Gene in *Phasianus*

Our other dominant gene is the one which Bruckner has designated *M*. It may have appeared relatively recently in *Phasianus colchicus* (but see p. 51) and has been given the varietal name *tenebrosus* by Hachisuka[6]. It is this gene

which accounts for the main characteristics of the type of pheasant discussed by Bruckner and called "mutant" by fanciers. Our observation on the adult plumage of *tenebrosus* and F_1, F_2 and back-cross progenies of *tenebrosus* and *mongolicus* are in agreement with those of Bruckner and will not be reported here.

The down color in F_1 approximates that of the pure mutant except that two slight variants occur within the group. About half of the chicks in our crosses were of a bright clear black color with a pure white throat and abdomen, and moderate white markings on the head and wings (shown by Bruckner, p. 49, Figure 6*B*). This coloring, which Darwin regarded as inexplicable in the fowl, is essentially that of a black Minorca chick, and may suggest a relationship between melanotic tendencies in *Phasianus* and *Gallus*. The rest of the F_1 young had their down plumage suffused throughout with brown which gave a buffy cast to the throat, obscured the head markings and produced a general effect of dullness (Bruckner; 6*A*). The two types are not associated with sex, nor with any plumage differences thus far detected in the adults. Both types are very distinct in coloring and in pattern from Mongolian or ordinary ringneck chicks. In our experience chicks like Bruckner's *A* and *B* in Figure 6 are heterozygous, while those like *D* are homozygous despite the fact that in adult plumage the latter is definitely darker than the former. Clear white markings in both *Phasianus* and *Gallus* chicks seem to presage a good black in the adult, while plain black or mahogany does not. In *Gallus*, chicks of this brown color are obtained from black × buff crosses.

The *W* Gene in a *Phasianus* × *Gallus* Cross

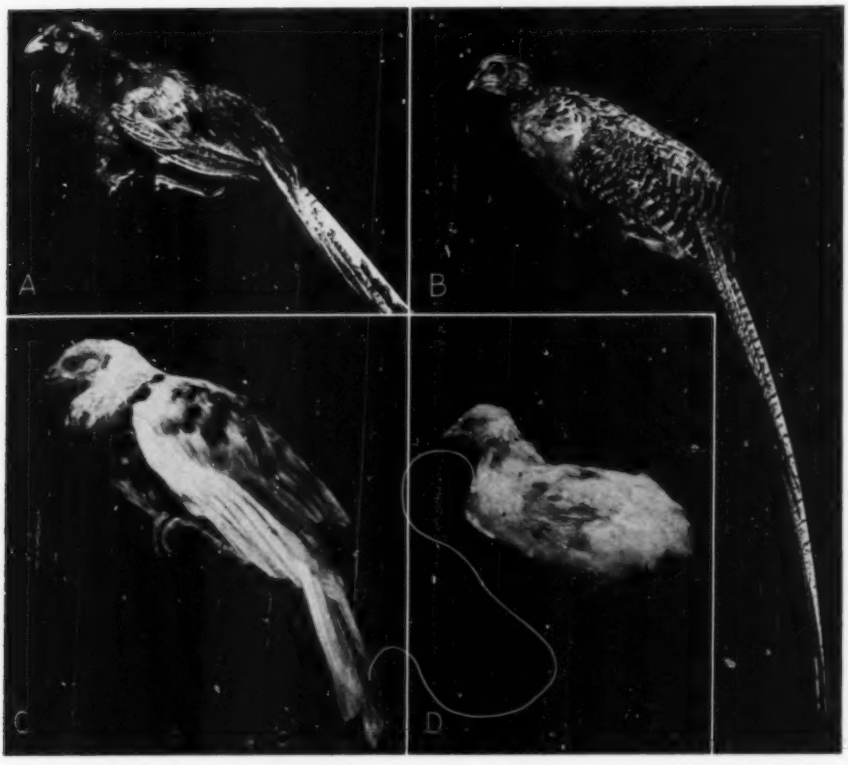
The effect of the *W* gene was studied in *Phasianus* × *Gallus* hybrids previously used in an investigation of sex-ratio (Sandnes and Landauer[10]). Hybrids produced in 1936 were sired by Creeper males, some of which were heterozygous and some homozygous for *W*. Presence of *W* was indicated phenotypically in 16 of the 25 chicks from this cross. In 1937 Salmon-breasted white leghorns, known in nearly every case to be homozygous for *W*, served as male parents, and all of the 139 offspring gave evidence of carrying this gene.

The female parents of the hybrids were typical representatives of the Ringneck pheasant (*P. colchicus torquatus*) among which variation in color was slight. The color pattern of the male pheasant is described by Bruckner on page 48 of this volume. The prevailingly white hybrids revealed few if any color traits reminiscent of their female parents.

A marked variation in color was evident in the down plumage of the non-white (ww) hybrids. Only two of these developed the definitive plumage of full grown birds. Melanic and ochraceous coloring predominated in both, and a careful examination of one of them revealed no white in the body plumage, although, as often happens in off-colored fowls, considerable white was evident in the primaries and secondaries. A trace of white was also found in the basal third of one of the tail feathers. These specimens are now in the American Museum of Natural History.

Hybrids of the Ww genotype, on the other hand, were found to resemble ordinary fowls heterozygous for *W* in the restriction of melanism and the expression of yellow and white. Black when present was limited to flecks, exceptional feathers and occasionally a sooty surface wash, the latter usually, though not always, restricted to the back and rump of grown males. Since some of the factors for black and yellow were supplied by the pheasant parents, it will be interesting to consider the hybrid in more detail.

Down plumage ranged from a pure chalky white through varying shades of buff to a light bronze, with or without dark flecks. The earliest juvenile plumages were almost pure white. After three or four months many birds began



SPECIES AND GENUS HYBRIDS

Figure 11

Golden-Amherst × Mutant-Mongolian quadruple hybrids (*mm*), male (*A*) and female (*B*). Ringneck Pheasant × Leghorn generic hybrids, *C* and *D*, are of the same age—about two years. All of the photographs were made to the same scale.

to show feathers with broad buff-colored terminations. Such feathers were most common in the dorsal tracts and secondary coverts. Observations on older birds indicate that the amount of yellow increased steadily with age in the young males but not in the females. Of the latter, there were but two that reached maturity, both of them with rudimentary ovaries and juvenile oviducts. One showed a slight amount of yellow in the plumage (Figure 11*D*), the other almost no yellow but a slight gray wash and a few black flecks. A third apparently intersexual as to gonads, size and bodily configuration had more yellow in its plumage. It is interesting that these apparently almost agonadic females did not develop a male or 'capon' type of plumage.

Adult male hybrids differed considerably among themselves in degree of yellow pigmentation, but even the lightest of them were darker than either of the young females or males. The greatest expression of yellow (a reddish tan or chestnut) was found in the dorsal feather tract, breast, sides and secondary coverts. The crown of the head, flanks and underparts were of a decidedly paler buff color, while complete suppression of yellow was manifest in most cases in the tail, primaries, primary coverts, in certain parts of the secondaries and in

an area of the neck corresponding to the green of the pheasant male. The distribution of yellow color in hybrid males and the pattern of individual feathers, when it shows through at all, is quite suggestive of the pheasant male.

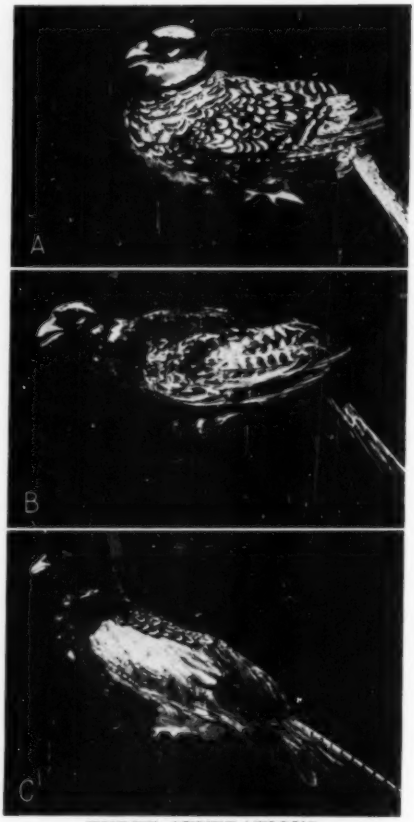
There are a number of points of morphological interest in these hybrids which will be described in another connection. Figure 11 shows a typical male (*C*) and one of the females (*D*) at the age of about two years. The difference in size between the sexes seems to be greater than in either of the parent species. The males are of interest in that they show a relatively short tail, no true sickle feathers, and saddle feathers even less fringed than those of an ordinary pheasant. Castration seems to have little or no effect on the form or color of the plumage.

So far as can be judged from this cross, the gene *W* introduced into a foreign cytoplasm and brought into association with a foreign genome behaves essentially as it would under normal conditions. Yellow pigmentation shows through as might have been expected. In some specimens the dark pigment pattern appears more prominently than it usually does in heterozygous fowls, which leaves open the possibility that in the latter there may be modifiers which somewhat enhance the dominance of *W*.

The *M* Gene in a *Phasianus* × *Syrmaticus* Cross

A male Reeves pheasant (*Syrmaticus reevesi*) was mated to a Reeves female and a female *Mm* (F_1 from a Mutant × Mongolian cross). The latter laid 12 eggs, of which eight were fertile and three hatched. Two of the chicks were light in color and curiously reminiscent of both Reeves and Mongolian young. Among Reeves they might have passed as Mongolian and among Mongolians as Reeves. One of them was lost, the other designated as No. 117, reached maturity (Figure 12*B*). The third chick was quite different in appearance. It had a rich dark mahogany brown color throughout, with the merest trace of buff on the throat, but otherwise with no appreciable variation between throat, belly and back. This chick was vigorous on the whole but grew very slowly. It produced only a few feathers but what there were approximated rather closely those of its *Mm Phasianus* relatives. By seven months, being still much undersized, it was killed and found to be a female essentially normal except for general emaciation and an underdeveloped ovary.

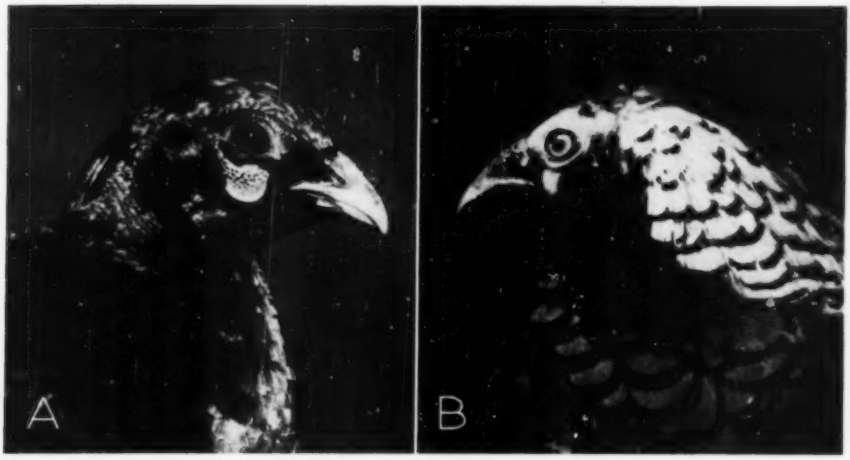
It is apparent even from these small



THREE GENERATIONS

Figure 12

A—grandfather, *Syrmaticus reevesi; B*—father, F_1 *Phasianus* × *Syrmaticus; C*—son, back cross to heterozygous (*Mm*) *Phasianus* × F_1. The backcross (*C*), although one-quarter Reeves, is very similar in plumage to Bruckner's heterozygous mutant *Phasianus* (Figure 5, *C*, p. 46).



A QUADRUPLE HYBRID
Figure 13

A—Golden-Amherst × Mutant-Mongolian, similar to Figure 11 *A* and *B*, except for differences in the effects of *mm* and *Mm* combinations; *B*—Amherst male. Note the "cape" which is a prominent feature in *Chrysolophus* but is scarcely expressed in the hybrid.

numbers that there was segregation between *M* and *m* in the maternal germ cells and that these two allels produced quite different effects when brought into relation with a *Syrmaticus* genome. The dominant *M* suppressed the Reeves pattern and determined the color for the whole body, while the recessive *m* made only an indifferent compromise with genes of the other species. The influence of *M* on the juvenile plumage in this generic cross was fully as great as in the varietal cross between *P.c. tenebrosus* and *P.c. mongolicus*.

The hybrid No. 117 and another similar bird obtained a year later from the same father and a Mongolian female show interesting interactions of the various colors and patterns of the two genera. At this time it will merely be recorded that some of the white head markings of the Reeves appear to be dominant and that in the absence of *M* the Reeves genome only partially suppresses the white neck-ring of *Phasianus*. In other parts of the body Reeves coloring is wholly or partially suppressed (Figure 12*B*).

Hybrid No. 117 was back-crossed to an *Mm* female and produced four young, three of which were dark and one light. Only one has survived. In ordinary phraseology this is ¾ *Phasianus* and ¼ Reeves. It is a dark male bird, obviously heretozygous for *M*, and very similar in coloring to an *Mm Phasianus*. It differs from the latter chiefly in showing only a trace of fringing in the rump feathers and in having the Reeves eye color and distribution of bare skin on the face (cf. Figure 12*C* and Bruckner, Figure 5*C* on p. 46).

There is no indication thus far that the Reeves genome has any inhibitory effect on dominant *M* from *Phasianus*.

The *M* Gene in a *Chrysolophus* × *Phasianus* Cross

The female parent in this case was an F_1 hybrid between a golden female and an Amherst male (*C. picta* × *C. amherstae*), the male parent a back-cross Mongolian × *Mm Phasianus*. In other words the "blood" of the chicks is ⅛ mutant, ⅜ Mongolian, ¼ golden and ¼ Amherst. The gene *M* was intro-

duced by one paternal great grandparent, its allel by some of the others. There were five light and three dark chicks. Of these, three females and two males survived. One of the males and all of the females were light at hatching, indicating an *m*(*m*)* formula. The other male in his down plumage was of a rich mahogany color similar to that of a *Phasianus* × *Syrmaticus* chick carrying *M* and differing from some *P.c. tenebrosus* × *P.c. mongolicus* chicks only in being of a richer and more uniform brown. The females (Figure 11*B*) are large, light colored birds, definitely intermediate, but closer to *Phasianus* than *Chrysolophus* in coloring. Their tails are longer than those of either parent species. The two males are similarly marked except that the light one (Figure 11*A*) has rufous central tail feathers while those of the darker are gray-green and barred. In general tone the birds are strikingly different, the one presumed to be *m*(*m*) is prevailingly of a fairly uniform rich red-brown color with an almost golden sheen, while the *M*(*m*) bird (Figure 13*A*) is of a dark mahogany color with a purple sheen. In this combination, as in the others, the *M* gene seems to increase the amount of melanin pigment in most parts of the plumage. The *m*(*m*) bird has shown good fertility in his second year and mated to *Chrysolophus* hybrids has produced a number of viable chicks. The *M*(*m*) specimen unfortunately escaped and has not been recovered.

Summary

The two dominants, *W* and *M*, which seem to have arisen from normal genes in *Gallus* and *Phasianus*, respectively, are not suppressed when brought into relation with genomes from entirely different species, even those that are ordinarily considered generically distinct. On the contrary, they appear to produce much the same primary effects in the new combinations as in the old. This speaks for a considerable degree of similarity between the different genomes tested and supplies little evidence that the dominance of these genes is dependent to any great extent on special auxiliary genes more common in one species than the other. It is true, however, that both of these genes are influenced somewhat in their expression by the new combinations and to that extent may be said to be subject to the action of modifiers. This is especially the case with the *M* gene when it is brought into relation with *Chrysolophus* germplasm.

The partial fertility of some of the hybrids is of especial interest. The bird combining one part Reeves and three parts *Phasianus* looks much like the latter but has a few traits definitely reminiscent of the former, just as an occasional wild species sometimes shows a trait that seems to link it with another species which on most grounds would not be considered as closely related. If the back-crossed descendants of our (*C. picta* × *C. amherstae*) × (*P.c. tenebrosus* × *P.c. mongolicus*) should continue to be fertile, one might perhaps build up a strain of *Chrysolophus*-like birds with a few traits derived from *Phasianus;* but, of course, this would not prove that the same thing often happens in nature.

Literature Cited

1. Bruckner, J. H. *Jour. Hered.* 30: 45-52. 1939.
2. Crew, F. A. E., and P. C. Koller. *Proc. Roy. Soc. Edin.* 56: 210-241. 1936.
3. Danforth, C. H. *Jour. Hered.* 24: 301-307. 1933.
4. Darwin, Charles. The Variations of Animals and Plants under Domestication. Amer. ed., Orange Judd & Co., New York, 1868.
5. Ghigi, A. *Proc. Fifth World's Poultry Congress.* 2: 3-13. 1933.
6. Hachisuka, M. U. *L'Oiseau.* 7: 297-299. 1926.
7. Haig-Thomas, Rose, and J. S. Huxley. *Jour. Genet.* 18: 233-246. 1927.
8. Irwin, M. R. *Jour. Genet.* 35: 351-373. 1938.
9. Phillips, J. C. *Jour. Exp. Zool.* 18: 69-143. 1915.
10. Sandnes, G. C., and Walter Landauer. *Amer. Nat.* 72: 180-183. 1938.

*The (*m*) represents the presumed allel from *Chrysolophus*.

THE INHERITANCE OF "NATURAL BANGS"

Catatrichy, a New Character Dependent Upon a Dominant Autosomal Gene*

S. EDMUND STODDARD

AN INHERITED SHORT FORE-LOCK

Figure 14

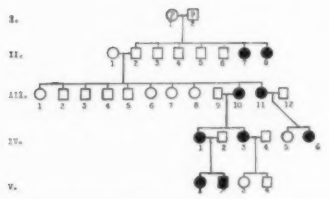
A photograph of IV-1 and 3 in the pedigree chart (Figure 15). The short lock of hair can be plainly seen. This short lock of hair has not been cut and never grows beyond the length which is shown here.

FOR the past year the author has been recording data on a peculiar trait pertaining to the growth of human hair. A survey of the literature has revealed no record of such a character. To describe this trait is the thesis of the present article.

The trait is characterized by a front lock of hair growing to a length of only five or six inches. When this length is reached the hair falls from its follicle. New hair continually grows to replace the old. When the growing hair reaches a length of approximately five and one-half inches it likewise starts falling. This is a continuous process resulting in natural "bangs." This short lock covers a distance of about three inches on the top of the brow. The lock is comparatively or slightly curly whereas the rest of the hair may be straight or slightly curly.

The trait has been named catatrichy, from the Greek words *kata,* falling, and *trichos,* hair. The word therefore means

*Contributed by the Zoology Department of the University of Southern California, Los Angeles, California.



FOUR GENERATIONS OF "NATURAL BANGS"

Figure 15

Pedigree chart showing inheritance of a peculiar trait in growth of human hair, in which the front lock grows to a length of only five and one-half inches. When this length is attained the hairs fall and are replaced by new ones. The character is inherited as an autosomal dominant, and is more readily detected in females than in males.

the condition of falling hair. For pronunciation the term would be divided as follows: ca ta′ tri chy.

A study of Figure 15 indicates the trait is inherited as an incomplete autosomal dominant. In the second generation 1 and 2 show no indications of the trait. II-7 and 8 have the short lock of hair. Of the ten children in the third generation two girls have the anomaly. III-10 has two girls, both of whom have the short lock. III-11 likewise has two girls, but only one shows the characteristic. Of the 14 girls in the study, in whom there is a possibility of showing the short lock, eight actually possess the trait.

It will be noticed that all individuals having the trait are females with the exception of a six year old boy (V-2). It is very difficult and at times impossible to detect the trait in men. In the case of men the hair is cut before the length of five or six inches is attained. Because of this cutting the contrast of a short lock surrounded by longer hair is impossible. However, the occurrence of the short lock in the hair of the six year old boy shows that males also inherit the character.

It has been thought necessary to study the hair types of the lock in comparison with the rest of the hair. The earliest microscopic study of human hair was by Pruner-Bey in 1863 and 1864. This investigator stated the more curly the hair the more elliptical its cross-section, and the more nearly straight the hair the more circular its cross-section. However, recent studies indicate the incorrectness of this theory. Madeline Kneberg[2] informs us that by the use of an improved technique it is shown that hair form cannot be predicted from the shape of the cross section. The study indicates that single hair shafts may vary as much as 27 index points (63 to 90). Hairs from the same head may also vary from 54 to 100 index points. Hairs, then, growing close together may vary as much as 46 index points. This investigator adds to these facts by stating that perfectly straight hairs may be flat and deeply waved hairs may be round.

Hausman[1] gives us a study indicating medulla form and cuticular scale form and size vary with the diameters of the hair shafts in which they occur, and not with the species, genus, or race. A hair shaft would exhibit the medulla form and cuticular scale form dependent on the given diameter. Since a single hair may vary so greatly in cross-sectional diameter one can expect to find regions in the hair exhibiting different medulla forms and scale sizes. Wynkoop[4] states that from a study of 483 specimens of human head hair from individuals ranging in age from three hours to 91 years, that the type of medulla was not correlated with the age of the individual, but was correlated with the diameter of the hair shaft. The same investigator also found hair shafts from one individual to vary as much as 54.90 microns.

With these facts in mind the author wished to see the relationship of hairs in the "bang" and in the remaining regions of the head. It has been possible to study only hair specimens from one individual (IV-6). Measurements showed the hair-index of various hairs in the lock ranged from 71 to 96. The hair-index indicates the form of the hair and is secured by dividing the least diameter of the hair by the greatest diameter and multiplying the result by 100. These

hairs, then, ranged from elliptical to nearly circular. Hairs from the non-lock ranged from 65 to 85 index points. Trotter and Dawson[3] state the average indices for American whites is 74. +.

The cross-sectional areas of the hairs were also determined. The area of a cross-section is secured by multiplying half the greatest diameter by half the least diameter and the product by pi. Hairs from the lock ranged from 0.0027 sq. mm. to 0.0039 sq. mm. Hairs from the non-lock varied from 0.0045 sq. mm. to 0.0056 sq. mm. The largest cross-sectional area of hair from the lock is smaller than the smallest cross-sectional area from the non-lock.

This study then substantiates the statement that the form of the hair cannot be determined from the cross-sectional shape of the hair. The wavy hair of the lock may be elliptical or round in cross-section. The medulla type has not as yet been checked, but the recent work on this subject indicates this would be dependent on the diameters of the hair shafts. Naturally, of the thousands of hairs in the human head, it might be easily assumed that there may be some hairs in the lock that would show a greater cross-sectional area than listed in this study, and that some hairs in the non-lock might be smaller than thus far found. However, if all the hairs studied show a relatively small diameter this is mathematically significant. Also by macroscopic examination of the hair it can clearly be seen that those from the lock are finer than from other regions of the head.

It is assumed, then, that the cross-sectional shape of the hairs from the lock cannot be a factor in determining whether the hairs are straight, wavy, or curly. But a significant factor in this trait of "natural bangs" is that the hair in the lock is, as a whole, smaller in cross-sectional area than the majority of the surrounding hair.

Literature Cited

1. Hausman, L. A. Histological Variability of Human Hair. *American Jour. of Phys. Anthro.* XVIII, 3. 1934.

2. Kneberg, Madeline. Improved Technique for Hair Examination. *American Jour. of Phys. Anthro.* XX, 1. 1935.

3. Trotter, Mildred, and Helen L. Dawson. The Hair of French Canadians. *Amer. Jour. of Phys. Anthro.* XVIII, 3. 1934.

4. Wynkoop, E. M. A Study of the Age Correlations of the Cuticular Scales, Medullae, and Shaft Diameters of Human Head-hair. *American Jour. of Phys. Anthro.* XIII, 177, 1929.

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Turkeys Up To Date

THE growing importance of the turkey industry is reflected in the large amount of experimental work now under way with turkeys and in the rapidly increasing literature dealing with this species. Both the authors of this latest book* about turkeys have made important contributions to our knowledge of turkeys and their management. Both have had an excellent opportunity to observe practices on commercial turkey farms and to develop sound judgment in practical matters.

The book has been written primarily for the producer and those who serve him. Everyone interested in turkeys will, however, find something of value in this book since the authors have attempted to get into the record practically all that is known about the turkey, including much original material.

Few first editions are free from defects and this book is no exception. Thus the arrangement of the material would have been improved had the principles underlying breeding been given first, followed by their application to practice. The same criticism applies to other sections of the book. Those defects are offset by an excellent index which makes it easy to find desired information. The book is well illustrated.

*Marsden, Stanley J. and J. Holmes Martin. *Turkey Management.* The Interstate Press, 708 pages, 1939.

With regard to the sections likely to be of particular interest to the geneticist and breeder the authors were faced with an unfortunate paucity of information based on work with turkeys. They met this difficulty in part by drawing on information obtained with other species, a procedure followed throughout the book. Care has been taken, however, to point out where information for turkeys was lacking. This is very necessary since what is true for one species is not necessarily true for another.

Several pages are devoted to a discussion of plumage color inheritance based almost entirely on work done by Dr. W. R. B. Robertson and summarized by him in an abstract of a little over half a page. This seems to be a case of reversing the usual procedure and perhaps accounts for errors in the account given. On page 135 an acceptable definition of epistasy is given. Unfortunately the example chosen—the Bourbon Red × Bronze cross—cannot possibly be interpreted as an example of epistasy either on the basis of all the information available nor on the basis of the genotypes of these two color varieties given on page 143 of the book.

Greater precision would be desirable in a few cases. As an example, a classification of the animal kingdom is given together with a description of the wild species and subspecies of turkeys. The authors state correctly that the eastern wild turkey (*M. gallopavo silvestris*) is the one most commonly met with in captivity. Nevertheless, it would have been better to make it clear which subspecies was referred to in the statement ". . . . adult feathers of the females will have *white tips* (or brownish tips in the case of wild turkeys)" since the eastern wild turkey is undoubtedly the one referred to. *M. g. merriami*, which is occasionally found in captivity, does not have brownish tips on the breast feathers of the adult female. The book contains much useful information that everyone directly or indirectly interested in turkeys should have access to. V. S. Asmundson.

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A LIGHT MUTANT OF THE MALLARD DUCK

Isaac R. Hunter*
Dowagiac, Michigan

More than 24 years ago the author's father started a strain of mallard ducks from eggs taken from the wild. The descendants of these wild birds have been closely inbred, especially during the past ten years. About 1933 a unique mutation appeared in the flock as a result of this inbreeding. Two hens were hatched which were almost entirely white on the breast, had a slight gray head and light wings and tail. The wing speculum was the only part having a solid dark color. These were the first light mallards, many of which have been produced here since then. As the author breeds only purebred livestock and poultry and believed this to be a cross between the mallards and a light domestic strain, they were disposed of without any experimental crosses being made.

In the spring of 1937 another female light mallard hatched. As there were no drakes of the light color and we did not wish to turn the light duck loose on our mallard breeding pond, she was mated in a pen with a fawn Indian Runner. This mating produced one light hen, two normal mallard hens, and one blue-gray drake. This same year (1938) five more light mallards were produced from our normal mallard stock. Of these three were drakes and two were hens.

The light ducklings are yellow and have smoky colored down on their heads and tails. They are the same size as normal mallard ducklings. The adult light mallards go through a summer and winter plumage change, being darker in the

*The author wishes to express his appreciation for the helpful suggestions given by the editor and by Prof. Jaap of Oklahoma Agricultural and Mechanical College.

LIGHT MALLARDS AND A NORMAL HEN

Figure 16

Photographs of a pair of light mallard ducks with a norman hen in the background. Both mutant hen and drake have normal wing speculae, and the drake has the characteristic green head. Both sexes are darker in winter. The "light" gene appears to be letha! when homozygous.

winter than in the summer. In the winter the light drakes take on the green heads characteristic of normal mallard males. The chief difference between light and normal mallards is a lack of blue-gray pigment in the light drakes and a lack of light brown pigment in the light females. The wing speculum is normal in both sexes as are most of the dark markings (Figure 16).

In the spring of 1939 we decided to mate the 1938 light mallards together. We also made several combinations with fawn Indian Runners. Results of these matings are given in Tables I-III.

Table I represents the Light Mallard × Light Mallard cross. Unhatched eggs in this and the other two matings were examined after hatching time. Fertility was excellent in this mating but mortality between about the 23rd day and hatching time accounted for a large percentage of the total eggs incubated. All were light phase mallards from this mating and all that hatched died within a few days.

Table II shows results of mating (Light Mallard × Fawn Indian Runner) × Light Mallard. This gave close to a 3:2 ratio of normal mallards to light mallards. Many of these died from 23rd day until hatching time and those that hatched were weak and died within a few days.

TABLE I. Light Mallard × Light Mallard

Hatching Date	Total Eggs Set	Infertile	Died Too Early to Determine Color	Died between about the 23rd day and hatching time, all Lights	Hatched and died within a few days, all light mallards
May 17, 1939	19	3	5	11	0
June 4, 1939	12	1	1	10	0
June 6, 1939	11	0	1	6	4
TOTALS	42	4	7	27	4

Table III shows Fawn Indian Runner × Light Mallard matings. There was less mortality from the 23rd day until hatching time than in the preceding two matings. This was the only mating from which adult ducks were obtained. The mallard characteristics were predominant in the progeny of this mating, some individuals approaching the light phase and others being blue-gray. Those that approach the light phase are not perfect as they have blue-gray backs and wings. It was thought better to include them all in one classification and designate them as blue-gray blends. Only one true light colored duckling was hatched from this mating, and it died within a few days.

Because of the high embryo-mortality of the light mallards it seems probable that these light ducks carry a lethal or semi-lethal gene.

TABLE II. (Light Mallard × Fawn Indian Runner) × Light Mallard

Hatching Date	Total Eggs Set	Infertiles	Died too early to determine Color	Died between 23rd day and hatching time. Normal mallard color	Light mallard color	Hatched and died within a few days. Normal	Light
May 19, 1939	27	2	4	11	6	1	3
June 5, 1939	32	6	3	13	9	1	0
TOTALS	59	8	7	24	15	2	3

TABLE III. Fawn Indian Runner × Light Mallard

Hatching Date	Total Eggs Set	Infertiles	Died too early to determine color	Died between 23rd day and hatching time. Blue-gray blends.	Light mallard color.	Hatched blue-gray blends	Hatched light mallard color
June 5, 1939	23	3	3	8	0	8	1
Sept. 2, 1939	6	0	2	2	0	2	0
TOTALS	29	3	5	10	0	10	1

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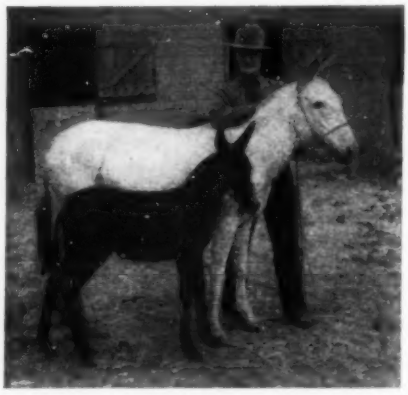
A FERTILE MULE FROM ARIZONA

From time to time fertile female mules have been reported, and this is merely another instance of this rare phenomenon. Mr. Lorenzo Hubbell, a trader of Oraibi, Arizona, purchased the mule from a Navajo Indian on July 25, 1939. Five days later she gave birth to the colt shown with her. So that an unquestionable record might be had, moving pictures were made of the birth of this colt. Mr. Hubbell states that there can be no doubt that the mother is a mule, on the basis of what he has been able to learn of her ancestry as well as her conformation. According to the Indian from whom Mr. Hubbell purchased the mule, the sire of this foal is a jack. The mule is nine years old, weighs about 700 pounds, and has had one colt previously, of which no description is available.

The ninth day following foaling she was bred to a crossbred Thoroughbred-Arabian stallion. The mule and her foal were exhibited at the county fair at Nephi, Utah, September 7, 1939.



MULE-LIKE FOAL AND MULE MOTHER

Figure 17

Photograph of the fertile mule and her male foal, which was sired by a jack and has the appearance of a normal mule. The mule has since been bred to a stallion.

HARRY H. SMITH
Utah State Agricultural College

FERTILE MARE MULES*

W. S. ANDERSON

University of Kentucky

THERE are very few living animals whose mothers are mules. Two of these rarities are owned by the Texas A. and M. College, and another is owned by W. H. Mobley and Son of Columbus, Indiana.

One of the two in Texas is a mare mule by a jack out of "Old Bec" described in this JOURNAL, Sept., 1928. She is not a three-quarter ass as her ancestry would indicate but a mule in all her features. Unlike her mother, she proved to be sterile. The other Texas animal is the son of a saddle stallion out of "Old Bec." He is a five-gaited saddle horse and has been shown as such at Texas fairs. He has none of the ass-like qualities of his mule mother. He has been mated to several mares and the foals by him show no evidence of hybrid blood.

Another animal with a mule mother, is a male foal by a Percheron stallion and was five weeks old in June, 1938, when photographed (Figure 18). He exhibits the Percheron characteristics for a foal of that age. There is complete absence of any influence of the ass ancestry coming to him from his mother. His owners intend to keep him and test him by breeding.

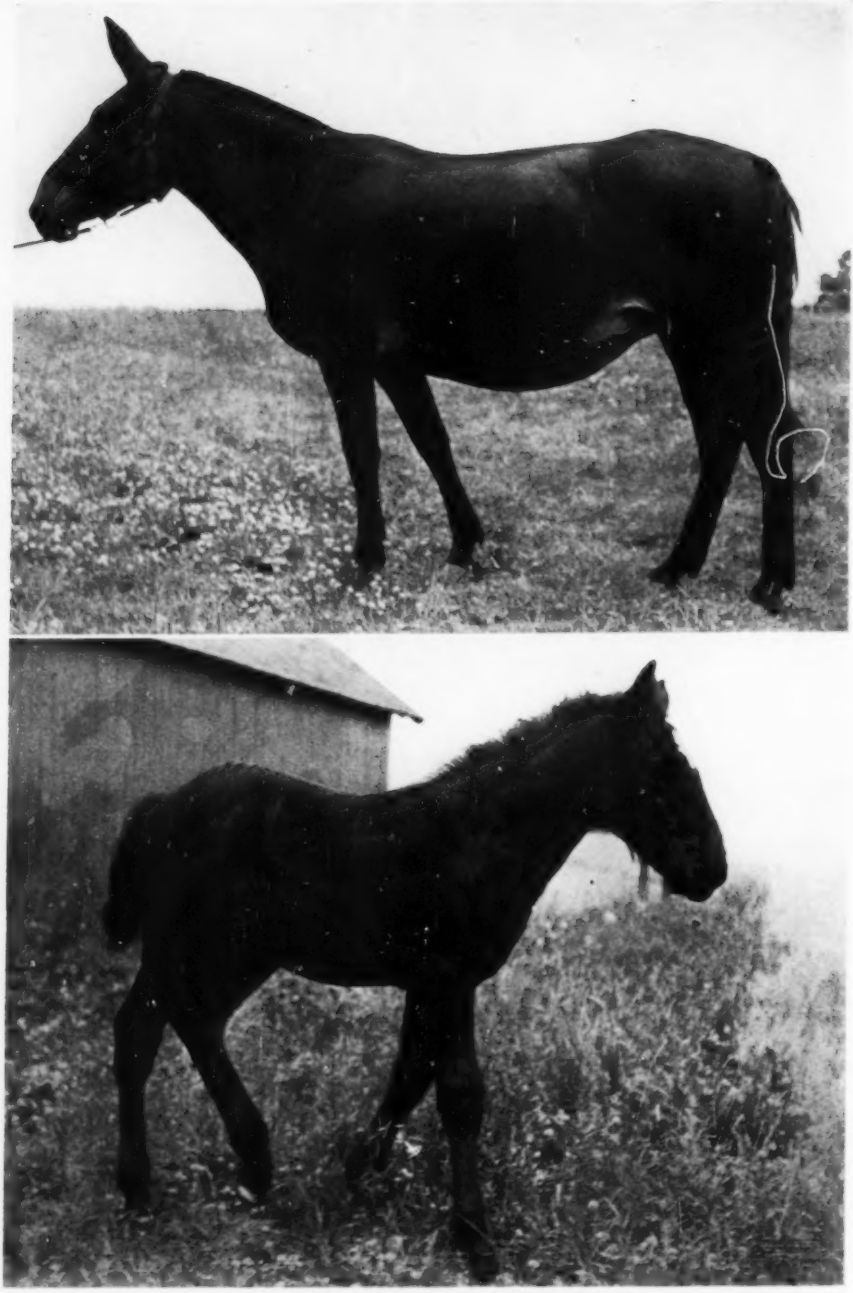
These three living animals explain those rare occasions when a female mule becomes a mother. It is known that the ass has a greater number of chromosomes than the horse. This difference does not interfere with an ovum of a mare developing when fertilized by a sperm of a jack; but when the hybrid reaches physical maturity and the gonads begin to function the inequality of the chromosome numbers prevents the reproductive glands from producing sex cells. The author has examined glands of male mules after castration but has never found any spermatozoa.

The production of the three animals by mare mules indicates that their ovaries did mature viable ova. Since two of the foals by stallions are horses without any features of the mule or ass, it is certain the ova that produced them carried no chromosomes from the ass. The mare mule out of "Old Bec" and by a jack is in every way a mule; not an animal with three-fourths of her genes from the ass. In this case the ovum evidently carried no chromosomes of the ass but only the chromosomes which its mother received from her mother, a female horse. The explanation appears to be, that if the female mule produces an ovum without ass chromosomes it is viable. It could happen, if in the division of the oocyte, all the ass chromosomes clung together and went into the polar, or waste cell, the final ovum would contain only the chromosomes received from the horse ancestry. If this hypothetical explanation be true then a viable ovum of a mare mule would carry the haploid number of horse chromosomes just as the ova of all female horses. On the other hand no viable ova are produced by female mules except the rare ones in which the sister polar cell carried away all the ass chromosomes.

This would explain the bearing of a horse-like colt by a fertile mule, recorded skeptically by Lloyd Jones in this JOURNAL in 1916. It was reasonably held that an animal with one-fourth ass ancestry should have some characters of the ass, but as pointed out above, this, instead of being ground for doubt, may really be what is to be expected in cases of mule fertility. As the word of the breeder was the main evidence, the rare occurrences were frequently looked upon with more doubt than interest.

Further evidence that the foregoing hypothesis is true is found in a recent

*A few days after this note was received similar information and another illustration of the Indiana mule and her colt were submitted by Dr. Edwin E. Jacobs, Ashland College, Ashland, Ohio.—Editor.



A FERTILE MULE AND HER COLT

Figure 18

Photographs of the female mule from Indiana and the horse-like foal she produced when mated to a Percheron stallion. The colt was five weeks old when the picture was taken. This survey of three instances of fertile mules suggests that some female mules may occasionally produce a pure horse ovum, uncontaminated by ass ancestry, and that these rare ova are fertile.

statement from the Texas A. & M. College that "the son of 'Old Bec' is fertile and has quite a number of colts around that section of the country. His daughters also are fertile. He is rather a popular sire locally and is used for saddle purposes." None of his offspring show any reversion to their ass ancestry. If he carried any of the chromosomes of the ass, hybrid qualities would appear in his offspring. The absence of ass-like qualities seems conclusive evidence that he himself originated from an ovum with no chromosomes from his grandsire, the jack.

In 1918 the Kentucky Experiment Station purchased a mare mule that had aborted a fetus of about four or five months of age. She was mated with a stallion but failed to conceive. The fetus was preserved and appears mule-like. The high fetal mortality rate of mules that conceive may perhaps be explained by combinations of chromosomes being formed which are only partially viable.

The dream of mule breeders has been to find fertile mare mules, hoping to get a race of perpetuating hybrids. The dream it seems cannot be realized as the reversion to the horse of the hybrid ancestry takes place, when they are fertile.

If the above hypothesis is correct, the two male horses out of mare mules hereditarily have no maternal grandfathers as the hereditary material which each mother mule received from her sire was all eliminated in the normal random assortment as the ova were produced, and only the mother's material gift of chromosomes entered the viable eggs from which the two *horses* evolved.

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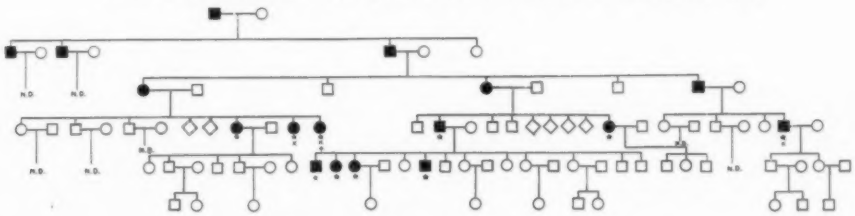
A DETAILED STUDY OF PICK'S DISEASE



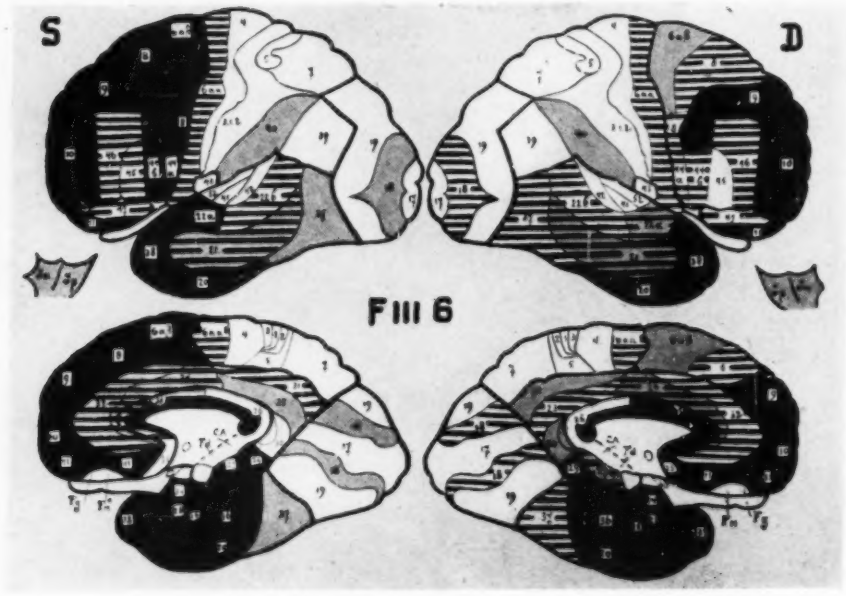
FOUR GENERATIONS OF LOBAR ATROPHY
Figure 19

Pedigree of a family carrying the simple dominant gene for lobar atrophy, a degeneration of the cerebral cortex starting in middle life. N. D. indicates Normal descendants; Stars—patients examined clinically; Crosses—patients studied histologically; Dagger—patient whose brain diagram is reproduced in Figure 20.

IT IS highly worth while to assemble and compare data upon individuals in the same pedigree developing the same mutant anomalies because from such studies we get a clear picture of the medical entity. Not only is the picture sharpened because of similar environmental and residual hereditary backgrounds, but we are dealing in each case with the same genetic entity, which may not always be the case when we study patients having the *same diagnosis* but chosen at random from the general population.

J. Sanders, V. W. D. Schenk and P. Van Veen have done an exemplary piece of work in their description of "A Family with Pick's Disease," published in English as vol. 38, no. 3, of the *Proceedings of the Royal Dutch Academy of Science* (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen), Amsterdam, 1939.

The one hundred and twenty-four pages of this study are divided into chapters on the Heredity of Pick's disease, Psychological family-research, Aplasia and mental decay, Anatomical investigation, Cortex of the hemispheres, Recapitulation, Case-histories, and Literature.



THE "PICK" BRAIN

Figure 20

Morphological findings of a post-mortem study of the brain of individual 12 in fourth generation of pedigree (Figure 19). White—neither atrophy nor loss of ganglion cells; Gray—loss of cells without atrophy; Black lined—atrophy of 40-80 per cent plus loss of many cells; Solid black—atrophy of more than 40 per cent, great loss of ganglion cells and of those present nearly all injured.

Pick's lobar atrophy is, as the name indicates, an atrophy of various parts of the brain which atrophy is accompanied by degeneration and loss of ganglion cells of the cerebral cortex. The brains of three of these patients were studied after preparation by various nerve stain and impregnation methods. The temporal and frontal lobes are particularly affected, as is shown by the diagram for one of their patients republished here. (Figure 20.)

The disease comes on in middle life. The first symptom may be an unwarranted fondness for sweets, followed by increasing degrees of forgetfulness. These patients become untidy, and restless. They wander about the streets and weep readily. They loose most of their speech, but keep on repeating certain words or phrases that they have retained. They lose recognition for relatives. The hands are kept in motion with rythmic slapping of the thighs. There is increased difficulty with walking, and when Pick's disease patients become bedridden they lie in bed with the legs drawn up. There they grasp the sheets, and grope with fingers, tongue and lips for objects proffered them.

According to the pedigree (Figure 19) which we have redrawn for this review, the disease is inherited as a simple dominant. Starred symbols represent individuals clinically examined. Unstarred symbols denote persons whose diagnosis was made through the description of relatives or from medical records. Cross marks indicate patients whose brains were studied. A dagger identifies the woman whose brain diagrams are republished herewith.

CLYDE E. KEELER.
Wistar Institute, Philadelphia.

EUGENICS IN RELATION TO MEDICINE

HAVEN EMERSON*

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IF WE lengthen our view and think not of year after next, but of the next generation and the generations after that, we find no conflict, but rather a remarkable unity of aims in the programs of eugenics and of preventive medicine. In the past, medicine has occupied an ever widening field of individual and social usefulness. The ultimate limit of its health-restoring and health-maintaining functions will not have been reached until it finds knowledge and develops techniques to reduce the inheritable defects of body and mind which afflict our race. More than this, preventive medicine should become a potent force in the self-determination of men and women to create a progeny of superior beings under those most enduring forms of social security, marriage and the family.

The only other professions which might function as "extension agencies" in furthering the eugenics program would be the priesthood and the bar. Their prestige in the community enables clergymen and lawyers to act as advisers in the adjustment of the lives of the people on the basis of the theological tenets of the church and of the social obligations of the law. Since adequate biological education is not required of these two groups they are not likely to be called to help establish a eugenic way of life. While we need their cooperation in the development of a fully rounded program we may question the validity of their judgment in medico-biological matters. It would be unwise, not to say unfair, to impose upon these groups burdens of leadership which properly belong to those better equipped to solve society's eugenical problems.

Without claiming that physicians are perfect, and admitting their serious limitations in ability, training, and social vision, nevertheless, they are better equipped to do this job than any other group. They should more generally be called on to advise those who contemplate marriage or are already creating a family. The application of human genetics directly to medical and eugenic problems should become an increasing function of the physician. The responsibility of the physician to keep up with the rapidly growing fund of knowledge about human genetics will add another burden to the heavy load physicians must carry. Even now, a new specialty, that of "Medical Genetics," is in process of developing.

Galton's definition of eugenics clearly sets forth the ideal of race improvement and stresses the only acceptable implementation of that ideal in a democracy. Eugenics, Galton said, is "the study of agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally." There is a good deal of latitude in that phrase "social control." If we construe it to mean a basic philosophy of self-control, rather than a compulsory dominance of the law, then the duty of physicians is plain. Within the limits of private practice, they must study the factors which can foster the finer potentialities of human mental and moral development in bodies capable of maximum biological vigor. The ideal of survival at the highest level, in terms of quality as well as of length of life, through selective application of the process of reproduction, is an important forward step in the philosophy of the medical profession.

Furthermore, it seems to me that physicians should have a large representation in those agencies which may be

*Based on a statement made at a conference on Eugenics and Medicine in 1937. The author is glad to acknowledge the cooperation of the Editorial Board of *Eugenical News* in the expansion of the manuscript to its present form.

set up to formulate and apply the compulsory action which will be necessary under "social control." In the case of those unfortunate individuals who seem certain to pass on socially dangerous or undesirable characteristics, it is essential that voluntary control of reproduction through education and persuasion be applied first. If persuasion fails to make procreation impossible and compulsion becomes necessary, this must be accomplished with adequate precautions, and with a minimum of violence to our humane instincts. The basic philosophy of eugenics has no place for arbitrary and cruel methods of bringing about the millenium.

So much for the general place of the physician in what we hope will become an increasingly eugenic-minded society. What can the physician contribute to the purposes of eugenics through his professional position?

At the start we should realize that it is a mistake to think of present efforts at social reform as though they represented an alternative non-eugenic desideratum. What we are doing now to ameliorate the status of the poor, handicapped, ineffective, and generally dependent, must be recognized as short-term "first aid" measures—not as an ultimate objective. Permanent forward progress can be attained only by an outlook cast in terms of a longer period, during which enduring benefits will replace the makeshift remedial devices used to make life tolerable for obvious misfits and incompetents. To lose sight of the need for long term planning, and for intensive search for permanent solutions, condemns the physician to a treadmill of direct action which must be endlessly repeated by his successors, and if the trends are in the wrong direction, repeated in appallingly increased volume and with more frantic haste. It is easier to tinker with a piece of junk in hand and "make it do" than to make the blueprints and forge the parts for a more efficient machine. If our tinkerings add to the size of the junk pile and if they are directed only to the emergencies of the moment, our rickety "Model T" of philanthropy may end by becoming a Juggernaut car, capable of crushing the life out of society.

The call of the crippled, the sick and the suffering must be met. It can easily grow so loud as to make us deaf to that grand symphony of the future, whose principal motif will be a chant of the gloriously fit rather than a discordant clamor for relief.

The physician can play his most hopeful part for eugenics by teaching to each individual and each family the facts of human biology. This will involve a further extension in medical school and later, of his already heavy fund of complex specialized knowledge. But he must do this if he is to free his clients from superstitions which generations of misinformation have almost made a part of us. These fictions must be destroyed. We must escape the dominance of social ideas and religious patterns incompatible with free inquiry into Nature's great experiment of evolution.

We have achieved such triumphs in our command over environment, we have made such progress in the nurture of our kind, that the inherently inferior, the sufferers from inherited and acquired deficiencies are but little handicapped in competition with their more fortunate fellows. This situation has very real dangers if we are to push on to better things. The strong and competent and moral, the free in body and in spirit, are shackled to those whose disablements so wring our hearts that our spirits cannot push on to the higher levels of achievement. Instead of levelling *up* we seem to be levelling *down*, and in the end we may very well level *out*, if we cannot mend this easily understandable but potentially harmful trend. As Lord Horder so aptly put it, "we have forgotten heredity, which if it does not work for us, works against us. We have concentrated on nurture and neglected nature." We neglect either of them at our peril.

In its essence and disregarding the necessary but confusing implications of practical details, an understanding of eugenics is merely the next step we must

take up the ladder of preventive medicine which we have climbed so successfully through the past century. We propose simply to prevent in-born illnesses as well as acquired illnesses, and to take such measures as our knowledge makes possible to enhance the physical and mental health of our race.

We have tasted the satisfaction of protecting the adult against advancing years, by guarding him in his workshop and helping him to choose his food and manner of life more wisely. The science and arts of geriatrics are increasingly practiced and make the upper decades of life more useful and enjoyable, which is as it should be in a population whose average age is rapidly increasing. Many discoveries have thrown around youth a protective net of knowledge which has removed some of the major hazards our grandparents could not escape. Long before beginning the adventure of school life we have surrounded our children with such precautions, and offered them such adequacy of food and cleanliness that in body at least they are generally sturdier specimens than their parents.

Design for Life

The infant today has five times as good a chance as his parents had to survive even through its first year. Part of this is due to an educational program to protect the mother during the months of pregnancy. What could be more natural, more in the spirit of evolutionary progress in science, than to push back still further the moment of scientific interest in human well-being. Prenatal care is now an accepted medical technique. The next step is pre-conceptional care, in that period before the genes have made their irrevocable selections and determined a new trend of human design. It looks as though it would forever be a hopeless ideal to urge children to choose better grandparents. But we can make it our business to ensure that people in the future will be better "grandparent material" than we are or than our grandparents were. The "Design for Living" of each of us is irrevocably intertwined with the genetic threads which have been woven together through the generations of our ancestors, to make of each of us a unique Design for Life.

The eugenic application of the knowledge we now have of human genetics is perhaps the soundest, and if we can believe the evidence of the biologists, is likely to prove the most profitable form of preventive medicine. Merely to find treatments for diseases is not enough. We should also learn as fast as possible to what extent genetic susceptibility and resistance to them exists among our people. This of course is quite in contrast to our present process, of waiting until immediate necessity forces us to take action, when it may be too late to avoid a heart-breaking setback in the march of progress. There is grave reason for believing that the reproductive policies we have recently been pursuing may already have brought us to the beginning of such a regressive episode in human progress.

The evidence is convincing that the reduction in the birth rate to its recent low levels, whether it be the result of natural or artificial practice, whether in the interest of self-preservation or self-indulgence, has a deteriorating influence upon the cultural pattern of society. It is essential that all the established facts regarding human reproduction should be as widely known as the intelligence and practical understanding of our people permits. Knowledge exists, though it is not yet everywhere available, which will give parents and particularly women command over their reproductive function. The spacing of births in a growing family to assure optimum conditions for mother and children would of itself justify the general distribution by physicians to men and women who seek their advice and instruction, of all appropriate information regarding the occurrence, the control, and the prevention of conception.

It seems to me that no hindrances of tradition, religion, or law can long delay the spread of such information. As our knowledge increases and as improved methods more safe, accurate and practically useful are developed, this will free

women of most of the accidental, and almost thoughtless occurrence of pregnancy which now exists among a large proportion of our people. Only when such control of our reproductive destiny has become universally accomplished can the production of a new human life be calculated with forethought and planned for in an enlightened manner. And on the other side of the shield, undesired and undesirable creation of life can be prevented with certainty and safety. Only then shall we have the essentials upon which to build the kind of families likely to increase the proportion of well-born and properly reared children calculated to satisfy the reasonable ambitions of those who would apply human genetics for eugenic ends.

All knowledge carries with it the hazard that it may be misused. Many a priceless fact has been exploited. To argue that as a consequence we dare not add to our knowledge and apply it constructively is a defeatist attitude. Next to his quality of being able to inhibit his desires for social ends, man's most precious attribute is perhaps his curiosity. As his knowledge becomes greater, so does his trusteeship responsibility increase to apply this knowledge in humane and constructive ways.

The medical profession exercises, as it were, the trusteeship of society in all sciences and arts which may prevent disease and make its occurrence more bearable and less likely to shorten life. Society will do well to demand of medicine that it consecrate its treasury of resources to the even broader values of constructive guidance towards better form and function of man's body, to a more nearly perfect life of thought and emotion, conduct and social adaptability, and to the longest span of human life consistent with happiness to the end.

No such visionary perfection as the eugenist dares dream of can be expected unless both medicine and society are allowed to develop free from the dominance of personalities and policies endowed by the authority of suffrage, or law, or military power with discretion over the lives of men.

If one were to outline the constructive and corrective, the positive and negative phases of a program of eugenics to be undertaken by the medical profession the following four propositions might be included:

1. Preparation for eugenic counselling by broadening of the medical curriculum.

2. Inclusion of family pedigrees as an integral part of medical records of the natural history of disease and health.

3. Encouraging of health examination of prospective mates as a basis for eugenic decisions for or against procreation.

4. An educational campaign to counter the exaggerated fear of the hazards of maternity among abnormally self-centered women. Promotion of confidence in the excellent chances of survival and well-being in childbirth, emphasis upon the emotional rewards to be found in children by those women who are physically fit and capable of devotion to the miracle of motherhood.

The following two may serve to correct errors of inheritance:

1. Permissive and voluntary acceptance of sterilization to stop transmissible defects of body or mind.

2. Contraceptive practice demonstrated by physicians for the health benefit of mother and children as a function of private practice with the encouragement of law and, when necessary, through government medical agencies.

The individual, the family, the nation, the race and the brotherhood of man appear to me to need the unselfish scientific application of eugenics in the creation of succeeding generations. In addition to this we must have some social structure which will permit the survival, by international agreement based on a discontinuance of physical might as a determinant of human conduct, of what is good in the sum of our individual lives, and in the collective advances of human society as a whole. Let us resolve that the babies of the future shall be well born, into a world free for the exercise of their entire capacity for the advance of their own lives and that of their fellows, without sacrifice of the lives of others as a condition of their own survival.

PREDICTING ADJUSTMENT IN MARRIAGE

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THE studies of predicting adjustment in marriage fall into two main groups: Those which deal with individual predictive factors separately and those which deal with combinations of predictive factors in such a way that they present an expectancy table with the probabilities of success or failure in marriage. Both of these approaches to marriage adjustment have obvious important eugenic implications. Up to the present time nine studies have been made of individual factors found to be related to success in marriage. These are as follows:

The first study by Hornell Hart and Wilmer Shields[5] considers only one factor, that of age. By comparing unhappy marriages appearing in the Domestic Relations Court with cases of all marriages as listed in the License Bureau, they found that marriages at early ages turned out more unsuccessfully than at later ages.

Katharine B. Davis[4] in a study of 1,000 married women, discovered that marriages were reported to be happier where the wife had more than a high-school education: where she was healthy at the time of marriage and where she reported no spooning or sex relations before marriage.

Gilbert V. Hamilton,[6] the psychiatrist, reported four findings that are probably significant for marital satisfaction: that the wife has a brother or brothers; that the spouses have equal education; that the wife physically resembles the husband's mother and that she had had no sexual intercourse before marriage.

Jessie Bernard[1] secured data indicating that marriages are more satisfactory to the husband when he is older by zero to ten years and to the wife when she is younger by zero to five years.

Kirkpatrick[7] reported that the wife is better adjusted in marriage if she has had no greater intimacy with either parent and the husband is happier when he has had before marriage no excess or deficiency of women friends.

Paul Popenoe[8] presented findings that couples who do not elope are happier than couples who do and that couples who rate their parents' marriages as happy are happier in their own marriage than those who describe the marriage of their parents as unhappy.

Clarence W. Schroeder[10] found seven marital items positively correlated with marital success: namely, parents' marriage reported happier than average; parents not divorced or separated; sex instruction from mother or from books; education beyond high school; attendance at church three or more times a month; attendance at Sunday School beyond 18 years; and being reared in country or small town.

L. S. C. Smythe[11] made a study of young Chinese married couples living in southern China. He found approximately twenty background items indicative of marital adjustment.

Edith Webb Williams[13] in a study of 200 rural couples, obtained results similar to those of the study by Burgess and Cottrell, which will be reported upon later in this paper.

The two remaining studies, those by L. M. Terman[12] and by Burgess and Cottrell[2], combined the separate factors into one general prediction score. Terman's criterion of marital success was the score of husband and wife upon a scale of marital happiness, the items of which are practically the same as those of the marital-adjustment index used by Burgess and Cottrell. He found 26 background factors significant for prediction. Factors having the highest positive correlation with marital happiness are: rated marital happiness of the parents (Above average or happier for

the wife, decidedly more happy than average for the husband); rated happiness of childhood (Above average for husband, average or above for wife); no conflict with mother; firm but not harsh discipline in the home; amount of attachment to father and mother; no conflict with father; frank attitude of parents toward early sex curiosity; relative mental ability where the husband is not inferior (with the wife's happiness) and where the husband is not much superior (with the husband's happiness); absence of severe and frequent childhood punishment; absence of disgust and aversion toward sex in premarital attitude of the subject, and in the case of the wife, absence of passionate longing.

Other background factors having a moderately high positive correlation with marital happiness are: age at marriage of husband, 22 and over, and 20 and over for wife; schooling of husband beyond high-school graduation, and one or more years of college for wife; first meeting of spouses was not a "pick-up" or at a place of private or public recreation; premarital acquaintance of three years or more for husband's happiness and one year or more for wife's happiness; length of engagement, six months or longer for husband's happiness and three months or longer for wife's happiness; the wife not being an only child; rating by husband of his mother as average or above in general attractiveness; some or no physical resemblance of wife to husband's mother; no, some, or close physical resemblance of husband to wife's father; sex instruction, even if rather inadequate (or even very inadequate in the case of the wife); chief source of sex information before 18 from parents or teachers; wife learning origin of babies between 6 and 16 years; no sex shock experienced by wife between 10 and 15 years; wife 12 years or older at first menstruation; wife never "petted" at high school age; and wife never desired to be of opposite sex.

The study of Burgess and Cottrell, based upon a sample of 526 couples, finds a correlation of success in marriage with premarital factors as follows:

1. Certain factors at the time of marriage show a rather high positive correlation with adjustment in marriage; namely, the marriage of the parents of both husband and wife reported as happy; approval of marriage by parents of the couple; superior family background of husband and wife; similarity of their family backgrounds; husband and wife not only children; husband closely attached to, and having little or no conflict with, his father and mother; wife's close attachment to mother; husband and wife reared in country; both attended Sunday School beyond 18 years of age; church attendance by husband two or more times a month; husband with graduate or professional education; and wife with college, graduate, or professional education; certain occupations for husband, and teaching for wife; wife employed at occupation the same as or similar to the one she prefers; income of wife $150 to $200 a month; husband had several or many men friends and several women friends; wife did not lack men friends and had many women friends; wife 15 or more pounds underweight; at time of marriage husband resided in suburbs; couple acquainted with each other two or more years; husband and wife kept company three years and were engaged three years and over; husband and wife 22 to 30 years old at time of marriage; couple married by minister, priest or rabbi.

Certain factors at the time of marriage show a moderate positive association with adjustment in marriage; namely, husband not attached to any brother or sister; wife not attached to any sibling except younger brother; wife closely attached to, but having no conflict with, her father; both regularly employed; husband with moderate income; husband and wife a member of three or more organizations; husband healthy; husband living at college dormitory or fraternity; wife had moderate income; wife employed seven or more years; husband had savings; wife's residence in small town or city suburb; couple married in church or parsonage.

The two studies by Terman and by

Burgess and Cottrell show that by combining these factors into an expectancy table it was feasible to predict at the time of marriage the probability of adjustment or happiness in marriage. Employing only background factors, Professor Terman obtained a correlation of + .35 for husbands and + .29 for wives. He secured correlation of personality items of + .47 for husbands and + .46 for wives. Combining background and personality items he reported a correlation of + .54 for husbands and + .47 for wives.[12] Burgess and Cottrell[2] report a correlation of background items with marital adjustment of + .56 for husbands and + .43 for wives.

These correlations secured in two independent studies in marriage prediction are promising for the future results of research in this field.

There is no doubt that statistical prediction can be somewhat further increased by including other significant items, but the greatest improvement in prediction will undoubtedly come about in two ways; first, classification of individual items into groups according to the underlying basic factors in marriage adjustment and, second, by supplementing statistical methods of investigation by detailed and complete case studies of successful and unsuccessful marriages.

By means of the analysis of the individual items found to be significant in the eleven different studies enumerated above, it appears that the different individual items entering into marital adjustment may be significantly classified under six basic factors. These are: (1) personality characteristics, (2) cultural backgrounds, (3) socialization, (4) economic status, (5) response patterns, and (6) sex desires.

What do the findings from the various studies indicate about the way in which these basic factors make for or against success in marriage?

1. Personality Characteristics

Six psychological characteristics have an important relation to adjustment in marriage. Both for the husband and wife, with one exception that will be noted, the following traits make for unhappiness in marriage:

an unhappy temperament, as indicated by predisposition to be pessimistic rather than optimistic; neurotic tendencies expressed by being touchy, grouchy, lonesome, feelings easily hurt, and bothered by useless thoughts; dominating and domineering, characterized by determination to get one's own way and by disregarding feelings of others when accomplishing desires regarded as important; critical and inconsiderate of others; (on the part of the husband) lack of self-confidence; and self-sufficiency, as indicated by usually facing troubles alone and avoiding asking others' advice.

It is interesting to note that the lack of self-confidence in the husband, but not in the wife makes for unhappiness in marriage. It is also significant to differentiate between self-confidence and self-sufficiency. Self-confidence makes for adjustment of the husband in marriage, but the self-sufficient husband or wife tends to be unhappy in marriage. Upon reflection this is what should have been expected. If both husband and wife are self-sufficient, there is not the same emotional need for each other that exists where both are mutually dependent emotionally upon each other.

Certain personality traits show little or no relation to success in marriage. Nearly all of the different personality items so far investigated seem to cluster around one basic factor that may be called the presence or absence of sociability. There seems no relation at all to adjustment in marriage whether the person is or is not sociable. Those who like the company of other persons and those who dislike the company of other persons, those who do or who do not give a great deal of thought to the kind of impression they make upon others and those who do or do not find it uncomfortable to be different are equally successful or unsuccessful in matrimony. In other words, the extrovert and the intravert have equal probabilities of being happy or unhappy in the marriage relation.

In the studies thus far made, the relation of a given personality item to a marital adjustment has been calculated independently for the husband and for

wife. Common observation, however, teaches us that it is a combination of personality characteristics that is important in a given union. Certain findings from our study of engaged couples now in progress,[3] reported by Winch,[14] confirms this point.

Taking the adjustment in engagement of the young man as the criterion, Winch found that by using forty-two items from the Thurstone Neurotic Inventory the couples could be grouped into four combinations, where both the young man and the young woman were not neurotic, where both were neurotic, where the young man was neurotic and the young woman was not neurotic, and where the young man was not neurotic and the young woman was neurotic. Fourteen of these personality items showed no statistically significant relation to adjustment in engagement. But in the majority of the items significant for adjustment in engagement a regular pattern was discovered, namely: The combination most favorable for the adjustment of the young man in engagement was where both members of the couple were not neurotic; the next where only the young woman was neurotic; the third where only the young man was neurotic; but distinctly unfavorable where both were neurotic. For example, if neither the young man nor the young woman have feelings of lonesomeness and if neither are touchy the prospect of adjustment in engagement of the young man is highest; but it is almost, although not quite as high, if he alone is without feelings of lonesomeness and touchiness; less favorable to his adjustment is the combination where he but not the girl feels lonesome and is touchy; least favorable where both have marked tendencies to lonesomeness and touchiness.

Interestingly, certain personality items do not follow this general pattern. The following combinations of items which are divergent illuminate this point:

On the trait, "easily moved to tears," the best combination for adjustment in engagement is where the man is easily moved to tears and the girl is not. The poorest combination is where the man is tearless and the young woman cries easily. The second-best combination is where both weep with difficulty, followed by the union where both shed tears on small provocation.

On the characteristic, "making friends easily," the most unfavorable situation is where the young man does not and the young woman does make friends readily.

On the trait, "feelings of inferiority," the combination most unfavorable to adjustment in engagement is where the young man is troubled with feelings of inferiority and the young woman is not.

On the characteristic, "frequent day dreaming," the one which militates most against adjustment in engagement is that of the day-dreaming young man and the non-day-dreaming young woman.

The findings of Winch conclusively indicate the importance for the prediction of adjustment in engagement and marriage of taking in combination rather than separately the personality traits of the man and the woman. There seems to be no doubt that compatibility in temperamental and personality traits is highly important for marital adjustment.

2. Cultural Backgrounds

Certain items about the parents of the bride and the bridegroom indicative of their cultural background proved to be associated with higher probabilities of adjustment in marriage. Among these were superior educational level; greater religious activity; higher occupational level of father; and a socio-economic status above average. When the family backgrounds of husband and wife were combined so as to show similarities and differences, it was found that likeness in cultural background correlated with success and unlikeness with failure in marriage.

Other significant findings from the study by Burgess and Cottrell bearing upon marital adjustment are (1) that the cultural level of the husband's parents is more significant than that of the wife's for marital happiness; (2) that certain cultural differences between husband and wife popularly assumed to be inimical to successful marriage, such as differences in educational status and wide differences in religious affiliations, show no relation to marital adjustment, at least in the first six years of married life; and (3) that residence in the coun-

try during childhood and adolescence is favorable, and residence in the city during those periods unfavorable to happiness in marriage.

If religious and moral beliefs may be taken as in general the result of early cultural conditioning two findings from Terman's study are of interest. He reports no relation to marital adjustment in cases where husband and wife do or do not accept the Bible literally or where they are or are not inclined to be Puritanical or old-fashioned in their ideas about the relations of the sexes. Apparently being modernistic or fundamentalist in one's religious thinking, or being old-fashioned or modern in one's ideas about the relations of the sexes has no bearing upon whether they will or will not be adjusted in marriage.

3. Socialization

A group of background items constituting what might be called the socialization factor in marital adjustment is found to be significantly related to success in marriage. Among these items are: higher level of education, objective evidence of religious activity, such as duration and frequency of attendance at Sunday School and Church; the number and sex of friends; the degree of participation in social organizations; and residence in neighborhoods of single-family dwellings. These items taken together may be regarded as an index of sociability, or of socialization, in respect to the degree of participation and achievement of the person in the activities of the community and its chief institutions—the family, the school and the church.

The impress of social institutions upon a person may be measured in terms of his conformity to social rules, his respect for conventions, and his stability of character. The socialization of the person which results, prepares him for adjustment in marriage. Where both the prospective husband and wife are socialized it is probable that wider divergencies in personality traits and in interests and values will be found consistent with marital happiness.

4. Economic Status

In our study several economic items were found to be significantly associated with adjustment in marriage. These are as follows: occupations characterized by a high degree of social control, absence of mobility, higher economic status, greater economic security, superior education, and stabilized personality; a moderate income at marriage rather than a low or high income; in the case of the wife a gainful occupation before marriage, particularly as a teacher and perhaps also in skilled office positions; a regular work record before marriage both for the husband and for the wife and for the wife length of time held last position; and savings before marriage both by the bride and the bridegroom.

These economic items taken together gave a correlation of + .32 with adjustment in marriage. But when in connection with other assumed basic factors—personality characteristics, impress of cultural backgrounds, socialization, and response patterns—partial and multiple correlations with marital adjustment scores were worked out, the factor of economic status was found to have only a negligible influence upon happiness in marriage.

The explanation for the very low weight to be assigned to the economic items in marital adjustment is that they add very little to the items included under personality traits, cultural backgrounds, socialization and response patterns. Indeed it may be argued that the economic behavior of the person, at least so far as it affects adjustment in marriage, is an expression of these non-economic factors. Economic items such as moderate income, savings, occupations characterized by stability and social control, regularity and continuity of employment, may all be taken as indicating a stabilized and socialized personality which readily adjusts to the situation of marriage. But this is a type of personality that is strongly influenced by personality, cultural, socialization and response factors. The economic behavior of the person may

therefore be thought of as the resultant of these non-economic influences.

5. Response Patterns

"Falling in love" in our society typically takes one of two forms. The more romantic of these is infatuation, or "love at first sight" which is generally associated with notions of one's affinity, of supreme happiness in marriage, and of passionate love overcoming all barriers of culture class, and prudence. The more prosaic conception is that of love which gradually develops out of companionship and friendship. Here the emphasis is not upon personal beauty, sex appeal, or other external characteristics, but upon congeniality, mutual interests, and comradeship.

Few marriages, perhaps, can be classified as wholly romantic or as based entirely on companionship. These two aspects of the sentiment of love blend in every union of affection but in varying proportions. It is of interest and importance, however, to raise the question which marriages are more successful, those which are predominatingly romantic or those which are predominatingly based on companionship.

All our data bearing on this question pointed to the conclusion that, on the average, marriages resulting from comradely affection turn out happier than those chiefly inspired by romantic attitudes. For example, the longer the periods of acquaintance, courtship, and engagement the more favorable the prospects for success in marriage. So also it was found that unions approved by both parents of the bride and of the bridegroom turn out better than cases of disapproval by one or both of their parents. Then, too, it was not shown that marriages with a difference of several years between husband and wife are less successful than those where young people are of about the same age or the husband a little older as stressed in the romantic notion of love.

Case studies of adjustment in engagement and marriage throw light upon the process of falling in love. They indicate that the tendency to fall in love is determined by the response pattern fixed in early childhood usually, but not always, to the parent of the opposite sex. The affectional relation embodies as an essential component the temperamental and personality characteristics of the person evoking the response. The prevailing tendency, therefore, in establishing an adult love relationship is for the young man, other things being equal, to become attached to a girl with the temperamental and other personality traits that were significant to him in his response to his mother, and for the young woman to be predisposed to find satisfaction in companionship with a young man who has the same or similar characteristics of temperament and personality which had meaning for her in her relation to her father. It should be added that under certain conditions, as when the affectional reaction was frustrated in childhood, the adult response will be directed in the reverse toward a love object of quite different personality characteristics from those of the parent of the opposite sex; and that, under certain conditions, the adult reaction will be influenced by the fact that the childhood response was directed toward the parent of the same sex, or toward a beloved and admired brother or sister.

6. The Sexual Factor

The statistical data of Terman and the case-studies analyzed by Burgess and Cottrell are in agreement that, in general, the sex factor is secondary to personality and cultural factors in influencing marital adjustment. With the majority of couples, problems of sexual adjustment in marriage appear to be a resultant not so much of biological factors as of psychological characteristics and of cultural conditioning of attitudes toward sex.

The studies by Davis, Schroeder and Terman all indicate the desirability of sex instruction in childhood in relation to marital adjustment. Terman finds as favorable to marital happiness the receiving of sex information from parents, their frank response to child's early

curiosity about sex, that wife never desired to be of the opposite sex, had no sex shock from ten to fifteen years of age, and did not indulge in petting before marriage. Davis and Hamilton agree upon the findings of the unfavorable association with marriage adjustment of premarital sexual intercourse for the wife. Terman notes that sex relations before marriage militate against the marital happiness of both husband and wife unless it was restricted to future spouse.

Terman concludes after a careful examination of the returns from husbands and wives upon a mass of sexual items that only two sexual factors are with some certainty statistically significant for marital happiness, namely, similarity in sexual desires of the spouses and the orgasm capacity of the wife.

This review of the chief groups of factors in marital adjustment gives rather conclusive evidence of the importance of psychological and cultural factors. It appears to rule out the economic factor as playing any significant independent role in marital happiness at least in the first six years of marriage. It leaves unanswered, in any valid form, the question of the role of the biological factor in marriage adjustment.

The studies of the relation of premarital factors to adjustment in marriage so far made have been by persons trained in psychiatry, psychology and sociology. None has yet been made by a biologist. No systematic effort has so far been made to differentiate the biological from the other aspects of the factors entering into marital happiness. The only clearly biological item associated with adjustment is that of health of wife reported by Davis and health of husband before marriage noted by Burgess and Cottrell.

Yet it is evident that temperamental and sexual differences and probably many personality characteristics and perhaps some traits now assumed to be cultural are wholly or in part constitutional. Terman states that the personality items associated with marital happiness are "in some degree an index of the subject's temperamental predisposition to find happiness rather than unhappiness in the marital relationship."

If Terman is correct in his assumption that the replies to the personality items are indicative of a basic tendency of the individual to be happy in every life situation including marriage, and if this predisposition is temperamental as he asserts, then it would seem that adjustment in marriage is in large part constitutional and hereditary. It has been established by the studies of Burgess and Cottrell, Popenoe, Schroeder and Terman that the happiness of one's parents' marriage is associated with the happiness of one's own marriage. This relationship may, however, be the result of childhood conditioning or a cultural pattern quite as well as the inheritance of the temperamental predisposition to happiness. Then, also, the two sexual items found to be associated with marital happiness, relative strength of the sexual desires of husband and wife and the orgasm capacity of the wife, may be predominantly to be explained, either by biological inheritance, or by psychological fixation or by social attitudes.

Finally, there are certain physical and mental traits and conditions that are largely if not entirely constitutional and hereditary that must be taken into account in marriage. Of great importance is the probable inheritance in each given union of cancer, diabetes, mental disorder, epilepsy, Huntington's chorea, and other inherited physical or mental defects and deficiencies. In certain of these the probabilities of inheritance of the defect is known.

It is evident from the foregoing discussion that the most important future research project in the field of marriage adjustment will be one that combines in its planning and prosecution the services of biologist, gynecologist, psychologist, psychiatrist and sociologist. The representatives of each discipline working separately can make only minor contributions, the major and crucial research program will be organized and integrated so that adequate study can be given to the interplay of biological,

psychological and cultural factors in marriage adjustment.

Literature Cited

1. Bernard, J., Factors in the Distribution of Success in Marriage, *American Journal of Sociology*, 40, 49-60, 1934.

2. Burgess, E. W., and L. S. Cottrell, Jr., Predicting Success or Failure in Marriage. New York, Prentice-Hall, Inc., 354-355, 1939.

3. Burgess, E. W., and Paul Wallin, Predicting the Adjustment of Engaged Couples.

4. Davis, Katharine B., Factors in the Sex Life of Twenty-two Hundred Women, New York, Harper and Brothers, 1929.

5. Hart, Hornell, and Wilmer Shields, Happiness in Relation to Age at Marriage, *Journal of Social Hygiene*, 12, 1926.

6. Hamilton, Gilbert V., A Research in Marriage, New York, A. and C. Boni, 1929.

7. Kirkpatrick, C., Factors in Marital Adjustment, *American Journal of Sociology*, 43. 270-283 1937.

8. Popenoe, Paul, A Study of 738 Elopements, *American Sociological Review*, 3, 47-53, 1938.

9. Popenoe, Paul, and D. Wicks, Marital Happiness in Two Generations, *Mental Hygiene*, 21, 218-224, 1937.

10. Schroeder, C. W., Divorce in a City of One Hundred Thousand Population, Peoria, Ill., Bradley Polytechnic Library, Chapt. II, 1939.

11. Smythe, L. S. C., Marriage Study, A preliminary report (mimeographed) of a study by a seminar on the Chinese family at the University of Nanking, 1936.

12. Terman, L. M., Psychological Factors in Marital Happiness, New York, McGraw-Hill Book Co., 167-266, 1938.

13. Williams, Edith Webb, Factors in Adjustment in Rural Marriages, unpublished Ph.D. thesis, Cornell University, 1938.

14. Winch, Robert F., The Relation between the Neurotic Tendency and the Adjustment in Engagement, unpublished Master's Thesis, University of Chicago.

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Physical Anthropology and Human Genetics

IN so far as history can be said to provide a basis for prognostication, physical anthropology as a historical science has a considerable practical significance. The study of the bodily changes which man has undergone in the past gives a clue to the nature and extent of the changes which may be anticipated in the future. *But what is far more important for the same purpose is the study of man as he is today.* Sociological problems are becoming more and more forced on our attention and demand for their solution a conscious control of processes which have hitherto been left to chance. The improvement of health and physique and their relation to nutritional and climatic factors, the effects on physical type of the redistribution of the populations of the world, the results of the hybridization of different racial types, the relation of changes in the reproductive rate to human variability and the composition of regional populations, all these are practical problems which can be approached systematically and scientifically only if we have adequate data regarding the physical nature of man in the conditions under which he now lives.

We still lack this essential knowledge. In Great Britain, for example, there are no proper records which show the variability of different sections of the population living under different nutritional conditions and in different environments. Still less is there any real knowledge of the potentialities for growth and development of native populations living under optimal conditions of nutrition and hygiene. Yet a study of the normal variability of man today, and of his bodily reactions to environmental influences, must clearly be a necessary basis for any assessment of changes which are to be anticipated in the future. Let us note briefly the lines along which physical anthropologists may most profitably seek for this information.

The study of human genetics offers practical problems of considerable urgency, for no one doubts that the mode of transmission of hereditary defects, which may be manifested in structural abnormalities, metabolic disorders, or susceptibility to diseases of one kind or another, should be elucidated in all possible detail. The problems of human heredity form the basis of the whole science and practice of eugenics, and the eugenist requires to have all the data of human heredity at his disposal if he is to exert any conscious control over the destiny of mankind in the future. — W. E. Le Gros Clark in *Nature* 144, 1939.

FERTILITY DIFFERENTIALS AMONG PRINCETON ALUMNAE

Based on the Classes of 1891, 1900, '02, '12, '13, and '21

JOHN JAY OSBORN

THE growth of an urbanized civilization has greatly affected the direction of man's evolution. Cultural forces, especially in the last hundred years, associated with a rise in the general standard of living and improved sanitary and medical conditions, have acted with contraception to bring size of family under voluntary control. As a result, a "selection by death" through the survival of the few has tended in civilized countries to give way to a "selection through birth." Succeeding generations in some classes of our society have consequently tended to be more largely composed of those individuals born, that is, of those who come from parents who wanted children, rather than of those only who were strongest or luckiest as children.

Exactly how evolutionary trends have been affected by this new type of selection, which must act increasingly on the mental attitudes of parents rather than on the characteristics of offspring, is not yet understood. Many data have been offered showing inverse relation between fertility and I. Q., or between success in life and birth rate.[1] Most of this material has been gathered from large sectors of population. Differentials have been obtained between very different groups, between, for instance, white collar workers and farmers.

Recognition has been growing of the frequent existence of greater differentials between individuals of one class than between the means of different classes. It may or may not be important that college men are having less children than are day laborers. What kind of college men and what kind of day laborers, respectively, are having the largest families begins to seem much more important.

The following study is an analysis of a group of Princeton college students, perhaps fairly representative of all college men. Data on men (including non-graduates) of the classes of 1891, 1900, 1902, 1912, 1913, and 1921 have been used. College records, and records made twenty-five years after graduation supplied basic material for all classes except for that of 1891, when a forty-year record was used in addition, and for that of 1921, when an eighteen-year record was used. All men from these classes were included even when records were incomplete, to negate any bias. The outside limits of the error caused by incomplete and mistaken records were calculated in several different ways, and checked by a coincident questionnaire study on many of the same men. Means for the whole group may be low by not more than eight per cent, but the error must essentially cancel out in most cases when different sub-groups are compared. "Children" throughout are those surviving to five years of age, or to time of record.

Classifications of occupation were made as follows: clergymen; college professors; lawyers and judges; doctors; artists and miscellaneous; and businessmen divided into three groups by apparent business position as: successful businessmen (prominent executives, bank presidents, etc.); medium businessmen (owners of small businesses, moderate executives, etc.); and small businessmen (including, in addition, a small group of secondary school teachers). These divisions were of course subject to many errors, but as they were made without reference to other facts about the men involved, there was little opportunity for systematic bias. Comparisons with data[2] for equivalent occupational groups in other studies show that a fairly representative sample of college men was obtained.

The group as a whole shows a birth rate well below replacement. The combined classes, except 1891 and 1921,

show 1.56 children per man, and 1.81 children per married man. (This compares with estimated replacement values for a somewhat similar group of 2.3 children per man and 2.9 per married couple.) (Lorimer and Osborn.) These values and those given in Table I are for men twenty-five years out of college. Correction for completed families, by comparison with the records of the class of 1891 for which late material is available, would raise the combined means to 1.60 children per man, and 1.86 per married man. Table I lists also fertility of occupational groups. Clergymen, of course, have the most children. Successful businessmen are next in order, leading professors, lawyers, and doctors. Medium and small businessmen trail. Such a direct relation between apparent success in business and fertility has not often been found in the general population, though it has been observed before among college men.[3] Values for Princeton men included in *Who's Who* are also very high; these presumably prominent men lead in size of family all except clergymen. (The standard error of the mean children per man for successful businessmen is $\pm$ .084. Fisher's test[4] applied to the difference between this mean and the mean children per man for all men, shows a probability of the difference being due to chance alone of less than one in several hundred.)

Men from the same four classes were also ranked by scholastic achievement in college. Three groups were formed, of men having had respectively (1) very high, (2) medium, and (3) very low grades. Table II lists fertility values for these divisions. The increase in fertility with higher marks is quite striking. Fisher's test applied to the difference between the mean number of children per man for groups one and two gives a probability of the difference being due to chance alone of one in ten, but when applied to the difference between the means for groups one and three, gives a probability of its being due to chance alone of less than one in two hundred. Among these selected college men, at least, the popular conception of inverse relation between scholastic ability and fertility must be modified.

The most interesting differentials discussed so far have been between more and less prominent businessmen, and between high and low scholastic groups. That these are not simply repetitions of essentially the same groups of men is shown when the occupational groups are analyzed for grades in college. It is found that of successful businessmen (the most fertile of the business groups) only eight per cent are in the highest scholastic group (which contains twelve per cent of all men) and fifty-four per cent are in the lowest (and least fertile) scholastic group (which contains forty-eight per cent only of all men). Least successful businessmen include sixteen per cent in the highest scholastic group (more than the average). Professors, as might be expected, include fifty-two

TABLE I. Fertility of Occupational Groups (values, except when stated to the contrary, for children within 25 years of graduation)

	No. of Cases	Per cent Married	Interval Between Graduation and Marriage	No. of Children Surviving to 5 years Per Man	No. of Children per Married Man	Per cent Childless Couples
Total combined means for all classes except 1891 and 1921	1,388	86.4	7.4	1.56	1.81	17.55
Total as above corrected for completed families	1,388	-	-	1.60	1.86	-
Ministers	48	89.5	6.8	2.06	2.30	18.8
Successful Businessmen	158	93.0	6.2	1.97	2.14	15.7
Professors	53	90.6	7.1	1.77	1.96	20.9
Lawyers	201	97.5	8.6	1.70	1.76	13.3
Doctors	68	93.5	9.1	1.62	1.73	15.0
Medium Businessmen	386	86.7	6.5	1.56	1.80	15.9
Artists, Unsuccessful Businessmen	79	71.0	7.0	1.10	1.70	22.2
Princeton Men in Who's Who	73	90.4	-	2.06	2.27	12.1

TABLE II. Fertility According to Scholastic Achievement, and Activities

	No. of Cases	Per cent Married	Avg. No. Children Per Man	Avg. No. Children Per Married Man	Per cent Childless Couples
Men with highest marks (1)	168	89.5	1.62	2.04	13.0
Men with medium marks (2)	820	87.0	1.62	1.88	17.0
Men with lowest marks (3)	640	86.0	1.45	1.71	17.1
Men prominent in extra-curricular activities	206	87.0	1.90	2.07	14.0
Men prominent on athletics	229	87.0	1.81	1.85	20.2

TABLE III. Fertility of different Classes

	No. of Cases	Per cent Married	Mean interval between graduation and marriage	Mean No. children surviving to 5 yrs. per man	Mean No. Children per married man	Per cent childless couples
Class 1891	121	97	-	1.41	1.62	30.7
1900-1902	618	86	8.0	1.67	1.76	23.0
1913-1915	720	88	6.5	1.84	1.98	14.8
1921 (adjusted)	403	84	5.9	1.59	1.89	14.1

The detailed text on which this summary is based has been afforded supplementary publication as Document No. 1318 of the American Documentation Institute, 2101 Constitution Ave., N. W., Washington, D. C. It comprises 17 tables, 6 charts, and a bibliography of 40 titles. The price of this publication on microfilm is $0.70 and on photoprints is $5.20. Remittance must accompany order.

per cent in the highest scholastic group.

Two other classifications were available in the attempt to partially distinguish the "most able men" from the "less able": a group of those who were most prominent in extra-curricular activities while in college, and a group of the most prominent athletes. About twenty per cent of each group are included within the other. Values for the extra-curricular men are 1.8 children per man, and 2.0 per married men, and for the athletes 1.61 and 1.85, respectively (Table II). Compared with 1.56 and 1.81 for the means of all men, these two groups, especially the former, show higher than average fertility rates, though the differences are not enough to be very valid statistically. (It is interesting to note that the group of athletes also shows a higher than average death rate.)

There has been a general increase in fertility among the men studied since 1891 (Table III). Values for children per man and children per married man are respectively, for the class of 1891, 1.41 and 1.62; for the combined classes 1900 and 1902, 1.4[illegible] and 1.76; for the combined classes [illegible] and 1913, 1.64 and 1.85; and for the class of 1921 (corrected to a theoretical twenty-five years out of college) 1.59 and 1.89. Fisher's test for the difference between the mean children per man for the classes 1900-02 and 1912-13 gives a probability of the difference being due to chance alone of less than one in five hundred. The differences between the means of the classes 1912-13 and 1921 are probably not significant. (Study of distribution proves that the fertility differences found between classes are not caused by different proportions of more or less fertile occupational or scholastic groups in different classes.) It is of great interest that these increases in fertility should have occurred and have been greatest in the first ten years of the twentieth century at a time when rates for the population at large were going down very fast.[5] They seem to be associated with a decrease in the number of single men and of one-child families, and with a very large increase in the number of two-child families.

All these trends, within a specialized group of men, seem more hopeful than those for the population at large. Within a group which as a whole is falling way below replacement, some subgroups are almost replacing themselves, and, in general, those subgroups with highest fertility rates seem to be the most desirable. Of course it is impossible in any group ever to completely sort the desirable from the undesirable; we can only follow indications. But there is much need for further and better "intra-group" studies of this type. Perhaps they will help dispel the traditional pessimism of the eugenist.

Literature Cited

1. Roberts, J. A. F., Intelligence and Family Size, *The Eugenics Review*, 30, (4), 237-247. 1939. Lentz, T., Jr., Relation of I. Q. to Size of Family, *J. of Educ. Psyc.*, 18, 486-496. 1927. Sutherland, Relationship Between I. Q. and Size of Family, *J. of Educ. Psyc.*, 20, 81-90. 1929. Maxwell, A., and R. R. Huestis, Student Test Score Rank and Family Size, *J. Hered.* 21:211-215. 1930.

2. Huntington, E., and L. F. Whitney, *The Builders of America*, New York, William Morrow and Co. 1927. Lorimer, F., and F. Osborn, *Dynamics of Population*, New York: The Macmillan Co. 1934. Notestein, F. W., and X. Sallume, The Fertility of Specific Occupational Groups in an Urban Population, *The Quarterly Bulletin of the Milbank Memorial Fund*, 10, No. 2. 1932.

3. Phillips, J. C., Success and the Birth Rate, *Harvard Graduates' Magazine*, 35, 565-570. 1927.

4. Fisher, R. A., *Statistical Methods for Research Workers*, Edinburgh, 1934.

5. Kiser, C., Trends in Fertility of Social Classes, *Human Biology*, 5, 256-273. 1933.

POPULATION DOCTRINES OF FRANCE

FRENCH statesmen and social theorists have been worried about depopulation for five hundred years. After sporadic measures during previous centuries, a series of drastic but rather fantastic measures was inaugurated by Colbert, under Louis XIV, to prevent emigration, encourage immigration, stimulate marriage, and reward noblemen or bourgeoisie with 10 legitimate

children, or 12 children regardless of legitimacy. This early exposition of totalitarian demography was similar in conception and ineptitude to that later inaugurated by Italian Fascism under Mussolini. Population theories and programs underwent many modifications, reversals, and developments in France during the next two centuries and a half in response to progress in statistics, in response to political and social changes, and in response to currents of social theory. For example, during the early Nineteenth Century there was a distinct reaction from pro-populationist ideology to Malthusian doctrines. After 1850, with the discovery that population was growing very slowly in France, there was increasing interest in the causes of depopulation and measures for stimulating population growth. An almost unbelievable profileration of interpretations and proposals resulted. This trend was greatly intensified by the patriotic fervor and alarm aroused by the Franco-Prussian War, later the World War, and more recently by the rise of National Socialism in Germany.

The mainspring of pro-populationist propaganda in France is upper-class and nationalistic. Two main lines of attack have been developed: repressive and positive. Populationist sentiment in unison with Catholic sentiment has secured the adoption of stringent measures against abortion and against contraception—and compromised with social welfare interests and individualism by non-enforcement, and by providing ample opportunity for evasion. Population sentiment, this time with the active support of socialistic sentiment, has promoted the establishment of the family allowance schemes. An elaborate family allowance system, at first limited to civil servants and miscellaneous private industries, was established on a national basis by legislation in 1933, and has been greatly extended and stepped up since that time. The motive force in this movement, however, has been largely economic, and amelioristic rather than demographic. Mass sentiment in France has not been particularly interested in family increase, but it has welcomed the extension of family benefits.

Professor Joseph J. Spengler of Duke University has provided a brilliant account of the development of French population theories and programs in their demographic and social setting.* This systematic exposition and penetrating evaluation make a very substantial contribution to population theory.

Two defects of French population theory, aside from its versatile futility and confused compromises, are (1) its neglect of qualitative considerations, including eugenics, which may be attributed to its nationalistic motivation, and (2) its lack of adequate statistical basis, either as regards demography or as regards the economics of the family. Spengler gives a thoroughly adequate exposition of the first deficiency. We could hardly expect that he should be equally successful in overcoming the serious deficiencies in French social statistics.

The chapter on "Differential Natality and Fertility" is, in the judgment of this reviewer, quite inferior to the rest of the book. The fact is that there are no data on fertility by occupational or social status in France, since Bertillon's study in 1911, that are worth two sentences—since the few data available lack the necessary age control, and even Bertillon's data are meagre. An intensive analysis of fertility by departments, with control of associated variables, might yield some valuable information, but this has not been carried out conclusively. The author's preference for complicated sentences with strings of figures, instead of simple tables, is rough on the reader. Incidentally, the title of this chapter is tautological. The reviewer therefore suggests that before beginning this chapter the reader be prepared to skip, if his attention flags, to the next chapter on "Populationist Fears and Repopulation."

Even those not particularly interested in population will find this book instructive and stimulating. For serious students it is immensely valuable.

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*SPENGLER, JOSEPH J., *France Faces Depopulation*, Duke University Press, 313 p. 1938.

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Supply Department

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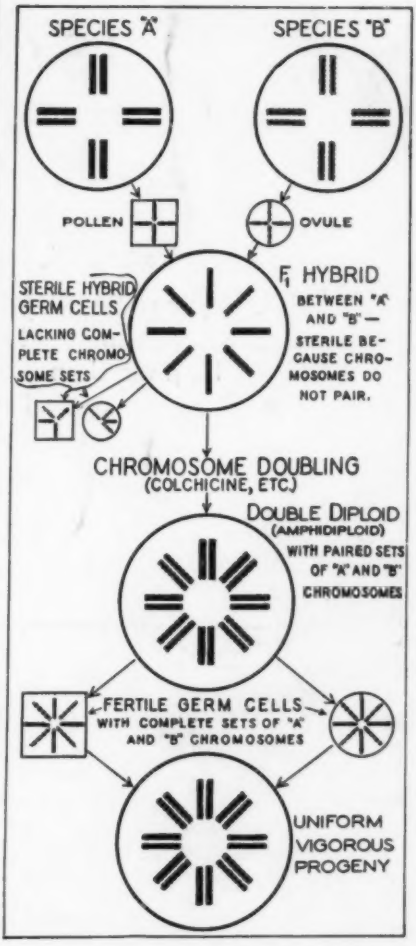
BAR HARBOR, MAINE


SPECIES "A"
SPECIES "B"
POLLEN
OVULE
STERILE HYBRID GERM CELLS LACKING COMPLETE CHROMOSOME SETS
F_1 HYBRID BETWEEN "A" AND "B" — STERILE BECAUSE CHROMOSOMES DO NOT PAIR.
CHROMOSOME DOUBLING (COLCHICINE, ETC.)
DOUBLE DIPLOID (AMPHIDIPLOID) WITH PAIRED SETS OF "A" AND "B" CHROMOSOMES
FERTILE GERM CELLS WITH COMPLETE SETS OF "A" AND "B" CHROMOSOMES
UNIFORM VIGOROUS PROGENY

ORIGIN OF DOUBLE DIPLOIDS

This chart was published in the December 1937 issue of the JOURNAL OF HEREDITY to show how colchicine should work to produce fertile "Double Diploids" from sterile species hybrids. At that time this had not been done experimentally. Since then, the prediction has been realized. The many illustrations regarding the use of colchicine to produce polyploid plants (articles in issues for: Dec. 1937, Jan. 1938, May 1938, June 1938, February 1939), and many other genetic phenomena are available as lantern slides. Send for free list of 250 lantern slides from JOURNAL illustrations.

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